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Engineering News-Record

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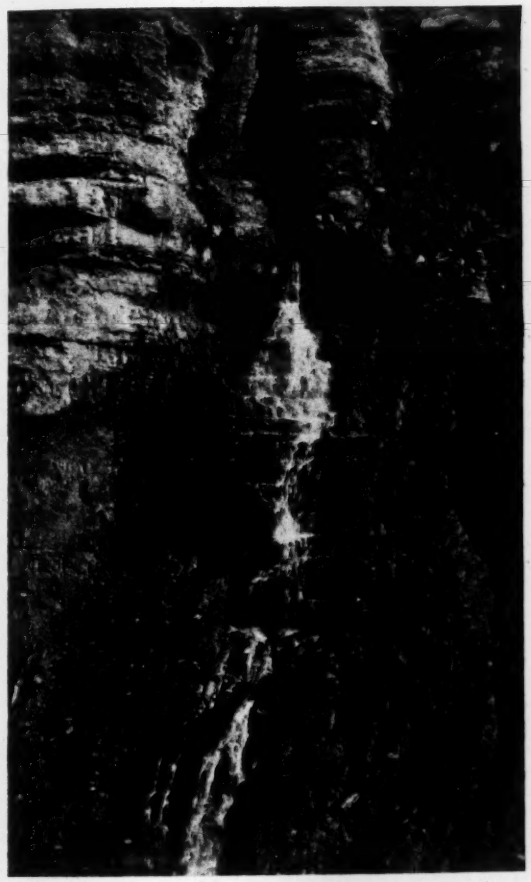

LEAK showing in cliff wall below a high dam. Considerable water, under a 150-ft. head, working around through rocks at one abutment and discharging from the cliff below

SAME cliff after leak had been stopped by asphalt, heated by electric wire in pipe through which it was pumped into a hole drilled down to the water passage in the rock above the dam

Asphalt Grouting Stops Underground Flow

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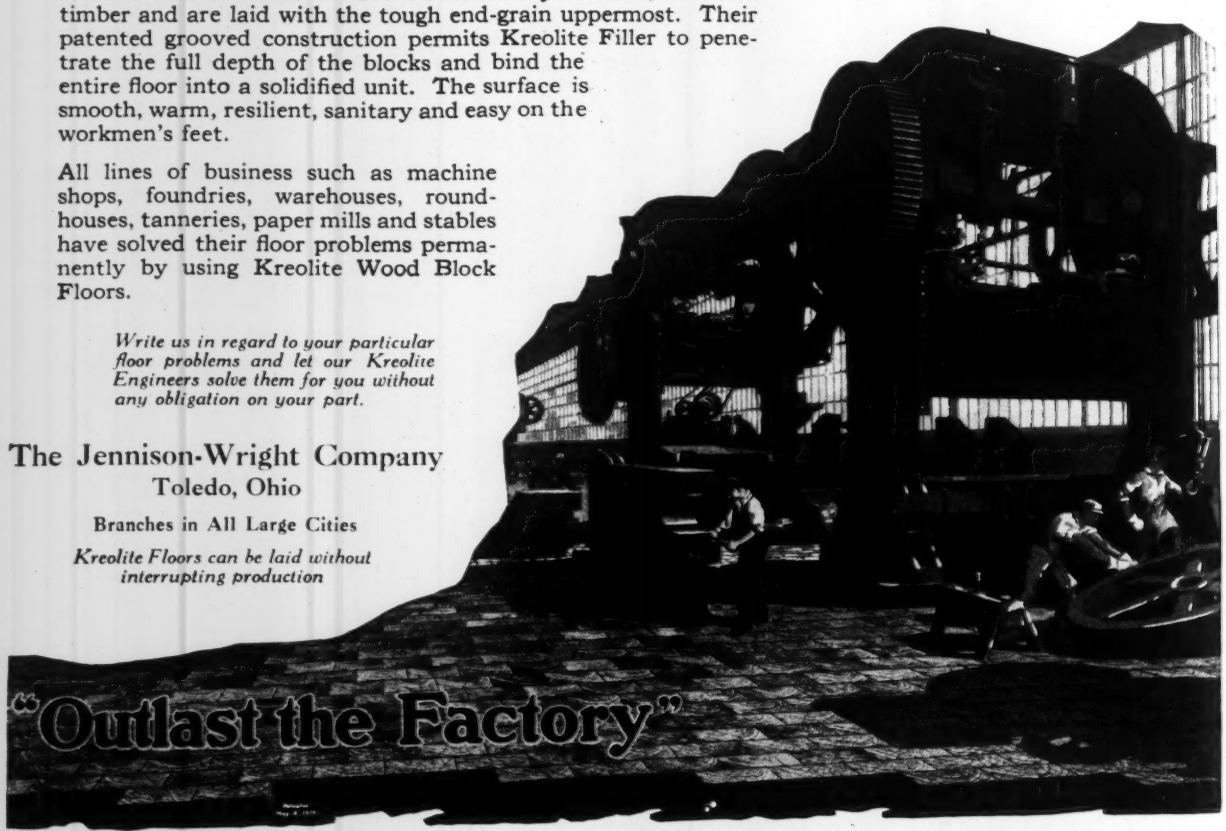


WOOD BLOCK FLOORS

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 96 NEW YORK, MAY 20, 1926 Number 20

Action Postponed

THERE is nothing in the settlement of the British general strike to indicate any change in the opinion expressed in these columns last week that England has come to the end of an era. Because the strikers were called off without wrecking the nation, because Englishmen preserved their characteristic sanity and composure in a time of stress, because the government did not capitulate, there is disposition to consider this settlement a great victory over the labor unions. As we see it, it is far from that. Labor obtained by the settlement just what it demanded before the strike, that is a reconsideration of the coal miners' wage and time scale. It obtained this by the pressure of an instrument hitherto not used in English speaking countries. That that instrument has been suggested in radical circles as the means whereby total revolution may be accomplished is unimportant. The British temperament is not hospitable to riot and destruction. But as a means whereby an end may be gained the general strike showed itself to be a formidable weapon, which will surely be held in reserve when need again arises. As was predicted last week, no one won the strike. All the more, therefore, must the industrial leaders of England take thought of the future.

An Invitation to Contracting

CONTRACT work is being invited on Missouri and Mississippi river improvement—bank protection and deepening channel—by the Chief of Engineers of the Army. The work contemplated is on those portions of the river from Kansas City to St. Louis and from Cairo to St. Louis for which the appropriations are respectively $2,000,000 and $3,000,000. On both rivers there will be the usual scattered operations; a rough count indicates about twenty tentative locations of work on the Missouri. Schedules for the Mississippi are not at hand but the improvements are certain to be located in a number of places. These are conditions that contractors have to keep firmly in mind. They call for rather expensive equipment, no very large volume of work in any locality and frequent shifting of plant if group contracts are undertaken. They too represent the conditions which furnish the best argument possible for government-owned equipment and force account operation. On them largely the U. S. Engineer Department has built up its justification for investing millions in working plant and for spending millions in day-labor work. By the same token these conditions offer contractors their greatest opportunity for incontestible proof that contract construction can meet and beat day-labor on its own grounds. Without buying more equipment, General Taylor announces that the corps of engineers cannot undertake the work specified. They, therefore, in the present case have no outstanding advantages in plant availability and rental. With a reasonable contract and specifications contractors can give their best in prices and speed of operation. There should be every effort of the chapters and the parent body of the Associated General Contractors to see that there are bidders or that the reasons for want of bidders are made plain.

A New Tool

IT IS unusually gratifying to learn from the description of the successful rock grouting done at Hales Bar dam with hot asphalt that another tool has been added to the construction equipment of civil engineering. Heretofore, fissured or leaky rock has presented formidable difficulties, and the success of more than one large enterprise has been threatened by its unexpected or at least undesired presence. The reader will recall that Hales Bar dam was a prominent case of just such difficulties, and that efforts of most extraordinary character were put forth in order to secure a dependable foundation. The final expedient of sinking pneumatic caissons for the foundation of the dam, and supplementing them with expensive pressure grouting with portland cement, overcame these difficulties by producing a secure and substantial structure. It was believed also that underflow had been cut off sufficiently to forestall serious loss of water. But in sequel this belief proved to be too optimistic; after storage began it was found that a material quantity of water bypassed the dam and power plant through the rock below. Grouting with hot-core asphalt was developed in answer to this difficulty, and it seems to have furnished a most satisfactory answer. The ingenuity of the method and its development are highly interesting. Even more so, however, is the promise held out that in future seamy rock conditions can be faced with confidence instead of doubt, because of this new tool now available.

Group Service by Engineers

THE organized engineers of Denver have served the city well in producing a careful study of the flood-control problem. Through the medium of an engineering council made up of the fourteen technical organizations representing both local societies and national branches they conclude that money is being wasted on inadequate construction which is based on insufficient study of the problem. They have the temerity to stand up in meeting before the city officials and tell them so. Plenty of time was taken for closed conferences with the officials. Publicity was deferred for a month and a half and *Engineering News-Record* was chosen as the medium rather than the daily papers, whose sensational stories have made such strained relations in the city that the mayor's three high-grade competent water commissioners, one of whom was an engineer, resigned April 1 and cannot be replaced. Competent technical or business men simply will not be pilloried in the Denver fashion. Under these circumstances the flood-control situation has been allowed to ride beyond what

ordinarily might be considered a reasonable time. whether the engineering profession as a unit in Denver can accomplish any tangible results by these peaceful methods remains to be seen. If not, more militant steps may be in order.

A Bold Design

THE West fully lives up to its long-standing reputation for courage and freedom from bonds of tradition in its project for the Gila River dam at San Carlos—a structure, by the way, which is to bear the name Coolidge Dam. A preliminary outline sketch of the design indicates a dam of radical proportions. In general form it is like a multiple-arch structure, but its arches span 180 ft. measured between buttress centers, while the height of the dam approximates 250 ft. The arch barrels are curved slightly in vertical section, so that they are domical rather than simply vaulted, hence the novel name "multiple-dome" dam. But whether domed or barrel-vaulted, they are of precedent-defying magnitude. Each will be subject to horizontal thrust of about 45,000 sq.ft. under an average head of 125 ft., which means a water pressure of nearly four tons per square foot. Under such conditions the problem of the dam buttress, none too simple heretofore, is greatly magnified. But difficulties often seem great only until they are overcome, and as the expert engineers called in by the Interior Department to review the design have given it their approval we may assume that the change of scale has been adequately dealt with by the designers and its problems solved. It will be of high interest, in any event, to learn details of the proposed structure, whose actual construction is to be taken in hand at once. The profession can only gain through the bold pioneering represented in the Coolidge Dam—remembering, of course, that no structure in the entire range of the civil engineer's art calls more insistently for thoroughgoing safety than a high reservoir dam.

Society Work Costs Money

TECHNICAL and business associations are rarely financed adequately. The more active and enterprising they are the more opportunities for constructive work they perceive and cannot grasp because of lack of means. This is the situation in which the Associated General Contractors finds itself. Briefly its staff managers are organized to handle a greater force of staff workers than there are means now to employ. Coincidently there is insistent need for study and pronouncement of practice in accident prevention, licensing contractors, standardizing lien laws and a number of other less important questions confronting contractors. The situation is uneconomic of course. What may be done about it? With the nature of the tasks now being performed less capable directing talent is not permissible. Management cannot well be curtailed. There must be an increase of staff workers. More staff workers require more income. Let us be specific. The allowed budget of the Associated General Contractors is this year $120,000. The managers are expending at the rate of $9,000 a month keeping well within the budget allowance. This expenditure too includes some funds for retiring notes. In brief, there is no deficit being incurred, no overrunning of the budget. Instead the association finances are improving. To put on a staff worker, a technical man of the caliber required by the problems to be studied, will cost with his operating expenses, some $12,000 a year. There are immediate problems to engage up to half a dozen such workers and the management overhead requires no increase for their direction. There are two ways of meeting the situation. One is to keep dues as they are and take up one task after another as a gradually increasing income permits; the other is to boost income by increased dues and attack several problems at once. The decision rests with the members and they should consider it well preparatory to the definite action called for by the finance committee.

Paradoxical High Wages

JUST how high do wages have to go to cease being fair and begin being extortionate? No one knows but it is becoming borne in upon a number of business men that their old ideas about wage limits need revising. President Litchfield of the Goodyear Rubber Co. last week at the Chamber of Commerce meeting crystallized some of these doubts into a philosophy of wages which, from the tone of the discussion, is accepted by some of the leading business administrators of the country. This theory is in marked contrast to many current views that wages are too high, for it expresses the paradox that they can be kept so high because they are high. In other words it is an expression of the interrelation of production and consumption. Higher wages mean a surplus to satisfy increased demands. Such satisfaction requires increased production. Increased production permits higher wages. This ascending spiral cannot keep up indefinitely, but it is limited only by the productivity of labor. So long as the unit output of the man increases, every cent more per hour he is paid raises the general prosperity of the country, by raising his own standard of living and by increasing his demands for the things his fellow workers make. If American labor continues to resist the pernicious theories of restricted output and American industrial leaders continue to maintain the view that high wages mean prosperity and that wages are the last thing to reduce when profits fall, the future need not be feared. The obligation, however, is equal upon labor and upon management.

Structural Progress

DEVELOPMENT activity has in recent times been particularly noticeable in the field of structural engineering. A decidedly progressive atmosphere has pervaded this field, containing promise of bringing about improvement of both views and methods. Experimental studies have been begun on a number of subjects, testifying to a general stirring of thought. Further evidence of the general forward movement is found in test and development work on the welding of structural steel. Just at present several large-scale programs are being worked out. The first of these reached the stage of final test last week, as reported briefly in the news columns of this issue. The structures concerned were roof trusses of conventional pitched-roof form, in other words what may be classed as very light structural steelwork. While no detail results are yet available, the gross outcome is to show not only that riveted work of this class has a satisfactory test strength, but also that welded trusses can easily develop at

least equal strength—indeed that welding makes it possible to develop the strength of the component members even more fully than riveting. Thus, the welded system of connection made a remarkable showing as to weight and efficiency. For the present it may be taken for granted that easy and true assembling of parts presents no greater difficulty with welding than with riveting, or that at worst it is a mere matter of devising suitable assembly methods. The cost of the welded connections also need not be considered a critical factor at the moment. The plain meaning of the test results, then, is to support the claims of fusion-welding advocates that the method has large and immediate possibilities for structural work. The further development and application of fusion welding to structural connections is therefore greatly encouraged. And, as an incidental result, the progressive trend in structural engineering, and the enlargement of its horizon, find further stimulation.

Educating Business

ONCE a year the Chamber of Commerce of the United states meets in general convention at Washington. Three thousand or more men representing all of the businesses and all of the industries of every section of the country come together for three or four days to discuss the problems of making and selling those things that men live by. The best thought of the leaders of business is there put into words and the summarized activity of a year's effort by the chamber's employed staff and designated committees is placed before a receptive audience.

It is inevitable that much that goes on in such a meeting will be commonplace, that there will be vain repetitions and specious platitudes. Such faults seem to lie beneath all of our group organizations; when more than a few men get together in parliamentary solemnity they lose some of their individual conciseness of thought and speech in high flown phrase and compromise opinion. The chamber meetings cannot escape this general criticism, but even such criticism does not seriously detract from the value to the country that these meetings have.

For it is a fact that there are here gathered probably the most representative lot of business men the country gets together. They are in Washington at this time with open minds to learn whither we are tending economically. They are not especially concerned with particular businesses; the woolen merchant isn't there to learn about Australian sheepgrowers nor the automobile manufacturer about motor saturation. They are all there as the part of the big whole of American business to learn of its problems and their relation to the social and economic development of the country. They are, therefore, in a most receptive state of mind for wholesome doctrine. And such doctrine they get, for the speakers, freed from the inhibitions of a particular business, take broad views and advance constructive thought. Much that a few years before would have been called radical has been put forward at these meetings by broadminded men who see the country as a unit and under such auspices has been accepted by the individual who had he heard such ideas in his own trade or business would have resented them and rejected them to his own disadvantage.

Business as a whole proves much more broadminded and progressive than the individual business man, and that individual, finding himself in an atmosphere of perspective thinking, cannot escape losing some of his narrowness. And so each one of these three thousand goes back to his own community and trade inoculated with a virus, which in turn he transmits to his own group. It is this disciplic transmission which is the greatest justification of the Chamber of Commerce of the United States. Its investigatory work is useful and necessary and its referendum opinions on public questions have a certain value in defining a state of mind, but its missionary work in inculcating in the average business man a forward looking attitude on the general problems of industry and economics is worth all the effort and money the organization costs.

Reversion to Type

REVERSION to type occurs in engineering design as well as in the organic world. A case in point is the growing use of separate sludge digestion tanks. In the earlier days of the tank treatment of sewage, the sludge was always removed from either plain or chemically aided settling tanks for whatever treatment was given it before final disposal. Then Cameron, of Exeter, England, introduced the septic tank to world-wide use, with sedimentation and sludge digestion going on simultaneously in a single receptacle. When studies of the process were begun at the Lawrence Experiment Station of the Massachusetts State Board of Health, the sludge was removed from the small laboratory tank for separate digestion, but however that may have been regarded at Lawrence it was generally considered as a laboratory expedient, and the self-contained septic tank rapidly circled the globe. Notable local exceptions occurred at Birmingham, England, and Baltimore, Md.

Then came Dr. Travis, of Hampton, England, a close and admiring student of the Lawrence reports, with his two-story tank, having a sludge compartment below, through which a part of the sewage flowed, thus continuing the combination and interference of sedimentation and digestion. Next, Dr. Imhoff, of Essen, Germany, modified the Travis design so as to separate the two functions, although all in one structure—a semi-detached digestion tank. The present rapidly extending use of the completely detached separate sludge digestion tank goes back to the Lawrence experiments and the still earliest of all working-scale tanks, from which the settled sludge was removed for further treatment, when it was given any. The activated-sludge process started as self-contained single-tank installation, but soon activation and sedimentation were separated. Contributing to separate sludge-treatment in both the septic tank and activated-sludge processes have been material progress in the perfection of sludge gathering and moving devices, now coming into wide use.

Reversion to type has been brought to the front not as proving that the earliest methods in engineering are best but chiefly as a matter of interest, though it is well to note the pioneers in engineering often did hit on what after years or decades of variation prove to be at least as good a way as any of doing a thing.

Practically, perhaps the most significant lesson of these tank experiences is that they prove anew the soundness of one of the most fundamental principles of progress, the division of labor and the finding and perfecting of the apparatus or method best suited to perform the work to be done by each minute subdivision.

Asphalt Grouting Under Hales Bar Dam

A New Method of Sealing and Its Detailed Operative Procedure

Fissured or Cavernous Strata of Water-Bearing Rock Successfully Sealed by Forcing in Asphalt in Plastic Condition Heated by Electric Wire—Large Underflow Cut Off—Procedure Described in Detail

By George W. Christians
Engineer, Chattanooga, Tenn.

During the construction of Hales Bar dam over the Tennessee River at Guild, Tenn., great difficulty was experienced in getting the foundations down to satisfactory bed work. After various methods had been tried, pneumatic caissons were sunk throughout most of the extent of the dam (see *Engineering News*, Nov. 13, 1913, p. 949), and in all cases conditions satisfactory in respect to safety and stability were obtained but not usually in respect to the watertightness of the underlying strata of limestone rock. A great deal of cement grouting was done during construction, with flooded cofferdams and other conditions as favorable as possible to remedy this condition. However, after the completion of the work considerable leakage developed from the pool above through fissures in the rock under the dam to the pool below. The results of a survey of this leakage are shown in Fig. 1. It was desired to stop or reduce the leakage.

Attempts to Close Leaks—The first attempt to stop the leakage consisted of dumping rock over one of the inlets and covering the rock with gravel and then clay. The result was only to increase the difficulty because the velocity of the water was sufficient to draw the fine material through and the coarse material in place merely served to widen and extend the area of inflow.

Later attempts to stop the inlets, after considerable silt had been deposited, consisted of stopping or checking the flow at the inlets by means of heavy rags, old carpets and burlaps covered with cinder concrete reinforced with strips of wire mesh. The concrete was let down in sacks through some 40 ft. of water and dumped at the bottom, the cinders serving very well to stop small remaining leakage through the rags. By this method it was found to be possible to seal any particular (though of course rather limited) area, but the leakage was not appreciably reduced because as soon as one inlet was sealed another would develop nearby. This was explained by the fact that the original river bed consisted of loose rock and boulders lying on the fissured rock below. All of the river bed except at the areas of inflow was covered with a layer of fine silt, which, though impervious, was not sufficiently strong to withstand the difference in pressure between the water in the pool and in the porous layer of loose rock below when adjacent inlets were closed.

Exploring Flow Channels—It was then decided to drill a number of holes down from the tunnel in the dam into the rock below with the idea of locating, perhaps, a few restricted passages which it might be possible to reach by cutting a shaft to them and stopping them under the dam by compressed-air work. Thus it might be possible to close the neck of the bottle rather than attempt to seal the whole river bed. Holes were drilled from a 2½x7½-ft. tunnel through the dam (Fig. 1). All subsequent work was carried on from this tunnel.

A sketch in Fig. 1 shows the condition found in the rock under the dam, and indicates the extent of the porosity within fairly well defined limits. The condition is believed to be due to solution and disintegration which proceeded in advance of the mechanical erosion of the river as it descended into the rock during past ages.

The crevices exist in the form of relatively narrow, irregular spaces in the solid rock foundations and do

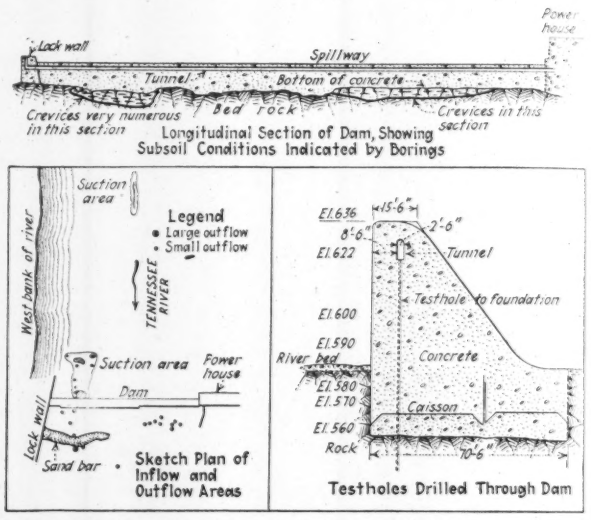


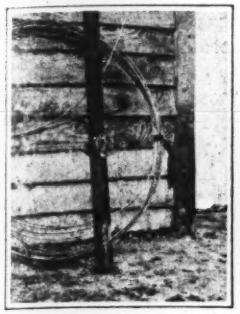
FIG. 1—UNDERFLOW CONDITIONS AT HALES BAR DAM

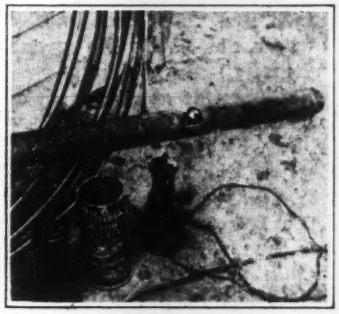
not materially affect the stability or permanence of the dam. They vary in size—2, 6 or 10 in. in depth, several about 20 in. deep and one 36 in. They apparently do not exist at clearly defined levels. They are separated by solid limestone rock. In some of the test holes several were encountered at different elevations, in others only one. Some were open spaces with water flowing through them, others were filled with mud; some contained gravel and some broken scales of limestone. Many crevices contained streams of water flowing at a velocity sufficient to shake and rattle the drill rods and tools. One exceptional crevice 3 ft. deep and running out horizontally about 30 ft. decreasing in size showed a flow velocity of about 360 ft. per min.

Water level in the holes varied to the extent of several feet, but usually was above tail water about one-third the total head. It rose and fell with the river stage. The water changed from muddy to clear as the river changed and the temperature was about the same as that of river water. Fresh leaves were washed up from the holes. All this information indicated that passages of river water were encountered and not underground spring water.

Special Exploring Instruments—Several instruments were devised to obtain information from the drilled holes. A crevice locating device (Fig. 2), used to check

the driller's record, consisted of four hinged links in a slotted pipe, the upper hinge fastened to the pipe, the lower to a movable weight inside the pipe, while the two other hinges were free to expand from the sides





FIGS. 2 AND 3—CREVICE DETECTOR AND FLOW METER

of the pipe as the weight was raised. The device was lowered into a hole by two wires, one fastened to the pipe, the other to the weight. By supporting the weight of the device from one or the other wire the links could be made to expand or contract. Wherever crevices permitted expansion, the wires would move 3 to 4 in. with respect to each other.

Fig. 3 shows a rather crude flow meter for measuring the velocity of water through the crevices. It consisted of a small fan wheel installed in a pipe between two openings facing in opposite directions. An insulated wire to a contactor on the fan-wheel shaft connected to a battery and telephone receiver and to ground above gave indications of revolutions of the wheel. By closing the side openings and leaving the ends of the pipe open vertical velocities could be indicated, and vice versa for horizontal velocities.

The first eight holes, put down with diamond drills, distributed over about 150 ft. of suspected area about one-fourth way from the west end of the dam, indicated that the porosity of the rock was widely distributed and demonstrated the impossibility of reaching it all by compressed air shaft.

A New Method—The writer then conceived the idea of filling these crevices with some such material as asphalt which could be forced into the crevice in a hot fluid condition and which would solidify quickly in the crevice as it came in contact with the cold water, so as to resist the washing effect of the moving stream. A necessary part of the scheme, of course, was to provide means for keeping the asphalt in a hot fluid condition as it passed down the drilled hole. This was to be accomplished by installing a pipe line in the hole, from top to bottom, the lower portion of the pipe perforated throughout the extent of the porous strata, solid above through the concrete of the dam with an electrical resistance wire installed inside of the pipe, fastened to it at the bottom, and held in the center and insulated from it by suitable insulators installed in the pipe couplings on the way up. An electrical current sufficient to maintain the required heat could then be passed down the wire and back up the pipe to complete the circuit, and the asphalt would be free to leave the pipe at any of the perforations which might be adjacent to a crevice in the rock.

Before authority was obtained to apply this idea to the dam, tests were made to demonstrate its practicability.

Small-Scale Tests—To demonstrate the penetration of asphalt through a certain character of small crevices filled with running water, a small hand pump immersed in hot asphalt was connected to a test chamber by 50 ft. of air-cooled pipe, then a right-angle turn with suitable fittings, and 50 ft. of water-cooled pipe. The test chamber consisted of a 10-in. steel pipe 10½ ft. long, filled with limestones about the size of one's fist. The asphalt entered through a 2-ft. length of perforated pipe at one end of the chamber, and water entered through a 2-in. pipe at the other end. The water left the chamber at ten 1-in. outlets along the length of the chamber.

Pumping of asphalt was started with a full stream of water flowing through the chamber and with the 50-ft. length of water-cooled pipe surrounded by and full of water. With the heating current turned on, the hot asphalt progressed through the pipe line, forcing out the water, and then into the test chamber. As the pumping continued, the asphalt progressed through the crevices in the rock in the test chamber, closing off one water outlet after another until the chamber was entirely full (the outlets were plugged as soon as they were reached to prevent loss of asphalt). The pressure required to fill the chamber was relatively low, not more than 50 lb. per sq.in., because the asphalt remained hot and fluid on the inside. When well heated up practically no pressure was lost in the pipe line.

FIGS. 4 AND 5—LEAKAGE CUT OFF BY ASPHALT GROUTING

The chamber was then allowed to cool and freeze up overnight, and the next morning pumping was continued at a pressure of 200 lb. per sq.in. Owing to the low pressure used during the introduction of the asphalt, numerous small spaces were left unfilled with the asphalt, and the effect of applying the 200-lb. pressure was to pack the asphalt into these small spaces. By taking out the plugs the progress of this packing effect could be watched. A very few minutes after starting, the cold hard asphalt began to expand from the first opening above the asphalt entrance pipe and the opening had to be closed. In a few more minutes expansion had begun at the next opening and at increasingly long intervals the packing effect progressed from one opening to the next until after 6½ hr. of continuous pressure the effect was becoming noticeable at the last opening, 6½ ft. from the asphalt entrance.

This test demonstrated that it is easily possible to force the asphalt into this type of crevice while hot and that when cooled, although a high resistance is offered, a 200-lb. pressure will slowly but surely pack it tightly into all of the irregularities of the rock cavities.

The second test was made to show how the method may be applied to shut off and stop the flow of water through crevices against a head of 36 ft., about 16 lb. per sq.in., which is the maximum effective head at the dam. The pump and piping were the same as used in the first test. The same test chamber was used, filled with stones as before. Asphalt entered the side of the chamber near one end. The water entered at the same end from a 2-in. supply line, flowed past the asphalt entrance, through the chamber and out the other end through bars bolted across to retain the stones. Attached to the water supply at the entrance was a hose, the other end of which was hung up to act as a standpipe for maintaining the head at 36 ft. The chamber was cooled on the outside by a spray from a hose.

In order to effect a closure as near as possible to the entrance of the asphalt, and by the use of the least material, the asphalt was pumped in intermittently and very slowly, so as to permit it to cool and congeal as it entered. For some time no noticeable effect was produced, but after a while the water flowing through was gradually decreased and the regulating valve had to be continually adjusted to keep the water head correct. Finally the flow of water through the chamber was entirely stopped. By examination through the plugged openings in the side of the chamber it was found that some of the asphalt had reached as far away as the second opening (4 ft.) but that the closure had been effected between the asphalt entrance and the first opening, just 2 ft. away.

Pumping was stopped and the apparatus allowed to cool over night, with water pressure on. The next morning pumping of asphalt was again started and it was found that the material in place offered a resistance of 125 lb. Of course, no water was flowing through. Pumping was continued slowly until a resistance of 200 lb. was attained, at which time the cold asphalt reached past the third opening, 6 ft. away. This test demonstrated that a rapidly flowing pressure stream can be effectually closed without the use of an excessive amount of material.

Grouting at Dam Begun—Permission was soon obtained from the War Department to begin operations on the dam. A small kettle and force pump were set up on the lock wall at the west end of the dam, close to entrance of the vertical shaft leading to the tunnel. An electrically heated pipe line was run down the shaft 28 ft., thence out the tunnel several hundred feet, depending upon the location of the hole, and then down the drilled hole to the perforated pipe in the porous rock below. This arrangement operated successfully for some time, but was later changed to permit operation on a larger scale at several holes simultaneously.

In the later set-up a large melting kettle was used with a rotary gear pump and a pressure regulating valve to bypass asphalt back into the kettle. By these means a constant pressure sufficient to move the asphalt to the farthest point was maintained on an electrically heated and heat insulated supply line which ran down the shaft and out the tunnel, finally over 1,000 ft., nearly across the dam. Numerous fittings were provided in the supply line for connecting any one of four small motor-driven force pumps in close proximity to any drilled hole. This arrangement, which permitted operation in four holes simultaneously, was continued to the completion of the work. Of course, details were altered from time to time, to perfect the workability of this method, which in many respects presented very unique and novel problems. These were worked out, however, and finally the system became very dependable and easily manipulated.

Drilling was started with diamond drills, but owing to excessive carbon loss these were replaced by shot drills, which were operated at about one-third of the cost per lineal foot. Sixty-eight holes were drilled, a total footage of 6,152, average depth 90 ft., maximum depth 134 ft. Into these holes 11,319 bbl. of asphalt was pumped, each barrel weighing about 500 lb. and containing about 7 cu.ft. The pressure used was limited to 200 lb. per sq.in.

Results Obtained—No difficulty was experienced in sealing any of the crevices encountered. Re-drilling into crevices formerly containing rapidly flowing streams of water gave asphalt cores at those places. Many asphalt cores were obtained. In one hole drillers reported ten different asphalt seams varying from 2 to 18 in. in thickness. The longest asphalt core obtained was 54 in. long; this was apparently from a relatively narrow vertical seam, because drilling nearby on either side failed to strike it.

As the work progressed many of the visible outlets below the dam disappeared entirely, others were greatly reduced. Figs. 4 and 5 show one of the larger outlets before and after asphalting. Usually the outlets became muddy for some time before stopping, indicating that the asphalt was forcing the stream into previously unused channels from which the water was cleaning out the mud. Occasionally asphalt appeared in the tailwater, but no appreciable percentage was lost in this way. Once it was observed in the forebay.

At the beginning of the work rapidly flowing streams were frequently struck, but during the latter part it became very difficult to locate a flowing passage. At the conclusion of the work not all of the leakage had been stopped but it had been reduced so much that it was thought the cost of locating the remaining leakage was not justified.

How the Asphalt Acts—The principle of operation of asphalt grouting is to pump a material which is fluid when hot, but not absolutely solid when cooled, such as asphalt, down through electrically heated pipes placed in drilled holes, into the crevices in the rock below. When the asphalt leaves the pipe and touches the water it congeals on the outside into a nearly solid condition which is tough enough to resist the pressure of a moving stream of water, but soft enough so that a moderate pressure from the pipe line can expand it from the inside until it fills and effectually seals the crevice against the flow of water.

It is necessary that the material be an insulator of electricity, a poor conductor of heat, insoluble in water, that it will melt at a moderate temperature, and that when cold it be stiff enough to resist whatever water pressure may be encountered but ductile enough so that a heavier pressure from the pipe line will slowly expand it into the crevices so as to make intimate contact with the rock surfaces. Asphalt fulfills all these requirements very well. In addition, when so placed it is as permanent as the rock itself.

When the asphalt emerges from the pipe into water it tends to assume a globular form (Fig. 6). The surface in contact with the water is congealed and forms a tough sac enclosing the hot fluid interior. As long as the flow from the pipe is continuous a fluid connection is maintained and the sac can be expanded until externally restricted. The strength or thickness of the enclosing membrane is controlled by the rate of expansion of the sac. When restricted the asphalt assumes the form of the cavity and expands in the direction of least restriction.

Sometimes when the cavity is large and the velocity of water very high the globule of asphalt may attain such a size without being anchored by the sides of the cavity that the pressure against it is sufficient to pull it away from the pipe. When this happens a thin rope of asphalt is pulled out which cools quickly on account of its size, and stiffens. It soon becomes entangled in the irregularities of the passage and as more is pulled out, forms a tangled mass which offers a distributed resistance to the flow of water until it builds back to the pipe as a foundation for a solid mass of asphalt.

The heat conductivity of asphalt is such that as long as the flow is continuous a fluid passage is easily maintained through the interior of the mass from the pipe line to the point of expansion, and the asphalt can be moved to considerable distance. In a 2 or 3-in. horizontal seam it is not at all difficult to force the asphalt several hundred feet if desirable (usually it is not). This is readily controlled by stopping the flow long enough for the fluid passage to solidify, then when operations are resumed the asphalt must start out again at the pipe until the crevice is completely filled adjacent to the pipe.

FIG. 6—HOW ASPHALT EMERGES FROM PIPE

When the cavity adjacent to the pipe is filled pressure is applied and maintained for a considerable time, although there may be relatively little flow of asphalt. This pressure has the effect of slowly moving the cold material until the hot material breaks through to some nearby unfilled space, or, if this is not possible, it squeezes the asphalt tightly to the rock surfaces no matter how irregular, so as to preclude absolutely the passage of water. The distance from the pipe at which this pressure on the cold asphalt is effective depends upon the size and nature of the crevice, the grade of asphalt used, the amount of pressure applied, and the duration of the application of the pressure.

In practice the grade of asphalt and the amount and duration of pressure are determined after careful study of the local conditions. Asphalt can be obtained of any consistency from that of a thick liquid to that of the hard, brittle, oxidized grades, and can readily be mixed and adjusted on the job if desirable. Usually it is desirable to start with a soft grade to fill the small spaces, then if necessary this can be backed up by a plug of hard material which as it is introduced squeezes the soft material into the small branching crevices.

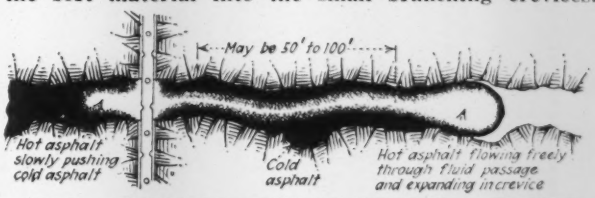

May be 50' to 100'
Hot asphalt slowly pushing cold asphalt
Cold asphalt
Hot asphalt flowing freely through fluid passage and expanding in crevice

FIG. 7—ASPHALT EXPANDING IN TYPICAL CREVICE

The pressure used must be considerably above any anticipated hydrostatic, usually several times. The upper limit of pressure is determined by the superimposed weight and the strength of the rock cavity, because it is possible to apply pressures which may burst up the rock structure. The duration of the application depends upon quite a number of conditions peculiar to the situation and to the particular hole.

Equipment for Grouting—The apparatus required is simple and inexpensive. A heating kettle for melting the asphalt, and a small adjustable-stroke piston pump driven by a 1-hp. motor are all that is required for handling the asphalt to the pipe line. The pipe is usually 1½ in., extra heavy throughout the upper portion, while that in the crevice-bearing rock is 1½-in. standard-weight pipe perforated by ¾-in. holes. It is heated by an iron resistance wire which enters through an insulated stuffing box at the top and is held in the center of the pipe by suitable insulators at the pipe couplings and fastened electrically and mechanically to the pipe at the bottom. The electric circuit passes down the wire and back up the pipe. The wire is kept taut by tension springs at the top. Patents have been granted on the method and apparatus.

In operation the pipe may be surrounded by water and thereby kept so cool that the asphalt touching it is solid, but the heat conductivity of the asphalt is such that a fluid passage is easily maintained next to the hot wire in the center so that the pressure is equalized from top to bottom of the pipe. The asphalt is free to emerge at any of several cavities which may exist throughout the extent of the perforations, and when back pressure is built up a definite assurance is obtained that all crevices encountered by this hole are filled.

The heating device not only keeps the asphalt in a fluid condition until it reaches the cavities to be filled but also makes it possible to resume operations after a shutdown merely by applying the heat for a few minutes before starting the pump.

Stress-Strain Relation of Asphalt—Some investigation was made into the physical characteristics of asphalt to determine the nature of its resistance in a crevice to a gradual movement by hydrostatic pressure from the dam. A penetration test was made for this purpose, using an 8-qt. pail nearly filled with a 15-lb. sample of the asphalt. The pail was immersed in water in a 12-qt. pail and a stream of water of uniform temperature provided. Two rods, each ¾ in. in diameter, were used, one weighted to correspond to 200 lb. per sq.in., which was the maximum pressure used at Hales Bar, and the other weighted to correspond to 16 lb. per sq.in., which was the maximum effective hydrostatic head at Hales Bar.

The curves in Fig. 8 show the results of one of these tests. The two curves are drawn to different horizontal ordinates as indicated; however, for comparison lines are drawn nearly vertical and horizontal to the same ordinates as the curve of the alternate test. This test cannot be used as a measure of resistance of asphalt in a crevice, but the flattening tendency, especially of the 16-lb. curve, indicates that there is a definite strain which asphalt will resist indefinitely and that cold asphalt, which can be moved readily by a heavy pressure, will be immovable at some lower pressure; so that when practical immobility has been reached at the high pressure, as is the case when pumping is stopped, a definite assurance is obtained that a much lower pressure will not move it.

It is interesting to note in this connection the difference between asphalt, which is a product from oil wells, and coal-tar pitch, which is a product of coal distillation and which in other respects is a suitable grouting material. With all grades of asphalt the relation of the time required for equal penetration for the two pressures is always greatly in excess of the relation of the pressures. For instance, a sample of asphalt gave a 4-in. penetration under the 200-lb. test in 31 min. and under the 16-lb. test in 6,244 min., a ratio of about 200 to 1. For a ratio of pressures of about 12 to 1, on the other hand, a sample of pitch, which seemed much harder and more brittle than the asphalt, gave a penetration of 4 in. under the 200-lb. test in 94 min. and under the 16-lb. test in 750 min., or a ratio of only about 8 to 1. This characteristic difference between asphalt and pitch can also be illustrated by taking a thin sample and bending it. When released the asphalt

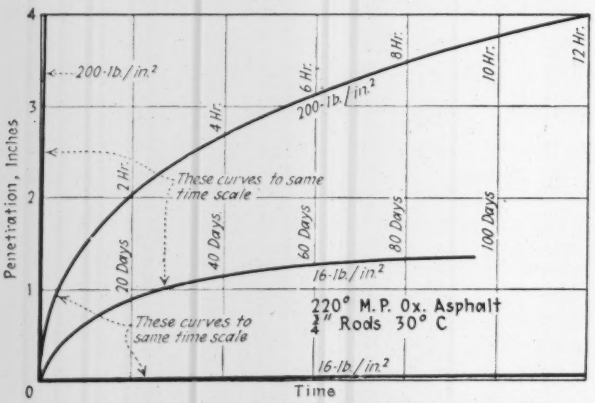


FIG. 8—RATE OF PENETRATION FOR ASPHALT
Test with ¾-in. needles loaded to 16 and 200 lb. per sq.in.; asphalt of 220-deg. melting point tested at 30-deg. C.

will spring back to almost its original shape, while pitch shows no elasticity and springs back imperceptibly, if at all, showing that asphalt is capable of retaining a resistance to distortion while pitch is not.

Asphalt vs. Cement Grouting—The advantages of asphalt grouting over ordinary grouting with cement and sand mixture are:

(1) It can be used to seal a passage through which water is flowing at high velocity. Wherever the asphalt comes in contact with water it hardens into a tough insoluble resisting material, which remains where placed. Cement grout washes, and even when the flow is very slight enormous quantities are washed away and wasted before a closure is effected.

(2) The perforated pipe may be extended down to any depth, and when pumping has continued until a high resisting pressure has been reached a definite assurance is obtained that all spaces adjacent to the pipe line throughout the entire extent of the perforations are filled. Cement grouting can only be successful at one point at a time, and when closure is effected it is impossible to determine whether the cavity is filled or whether the entrance hole or pipe has blocked up.

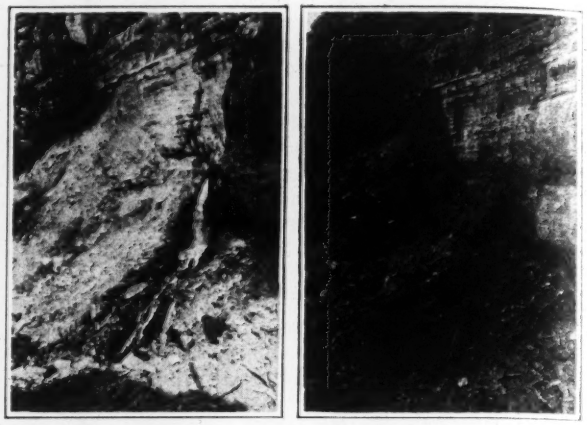


FIG. 9—GROUTING RESULTS ON A CLIFF FACE
View at left shows the face of the canyon wall below an American dam, where there were several leaks, of which one is shown in the figure, under a head of about 160 ft. In the right hand view is shown the same point after asphalt grouting.

(3) After finishing a hole the pipe and wire are allowed to remain, so that if in the future, even years later, it is considered desirable, connections may be made to the pipe and wire, and after heating for a few minutes the pumping can be started up and operations continued as though they had not been stopped. When grouting, a stoppage of only a few minutes will permit the cement to set up, so that a new hole must be drilled.

(4) The cost of asphalt grouting for waterproofing rock structures is usually much less than that of cement grouting. Asphalt costs per cubic foot about the same as cement, depending upon locality, freight rate, etc. The cost of placing it in the rock cavities is usually less, since the small individual pumping units, such as have been used at other dams, capable of pumping about one barrel an hour or about 160 cu.ft. per day, require only one attendant, whose principal duty is to attend to the melting kettle. No water or air lines are required and only 6 kw. per 100 ft. of pipe for heating uses.

(5) The effectiveness of the asphalt used is so much greater that fewer holes need be drilled and only a small percentage of the amount of material is required.

By altering the grade of the asphalt, adjusting the rate of flow, controlling the temperature in the pipe line, operating intermittently and to determined pressures, it is possible to adapt the method to various local conditions so as to obtain maximum results with minimum effort and material.

Stopping Leaks in Cliff Face—The method has been used to stop some leaks in a cliff face below another large dam. These were stopped against a 150-ft. difference in water level, by pumping asphalt into one hole drilled in the rock above the dam, which struck the water passage 140 ft. down.

The leakage was stopped at a pressure of about 150 lb. on the asphalt, but for security the asphalt was pumped in to a resistance of 600 lb. and held there until the reception of asphalt at that high pressure ceased.

Economics of Railway Relocation and Improvement

THAT reductions in ruling grade and in curvature are more important than shortening distance by line revisions or introducing powerful locomotives, was the keynote of a paper read before the Western Society of Engineers by Charles A. Morse, chief engineer of the Chicago, Rock Island & Pacific Ry., who said:

In locating a railroad in early days the object was to keep the construction cost as low as possible. As the cost of grading was one of the big items, the engineer sought a location which would require the least amount of grading, and he used unlimited curvature and a heavy maximum grade to fit his line to the contour of the country. By about 1880, the construction engineers were beginning to criticize the locating engineer; on a newly located line the former would relocate portions where it was evident that curvature could be saved and the line shortened by a little heavier work. But this referred only to cost of construction, no thought being given to comparative cost of operation. It was not until about 1890 that there was a general movement in the latter direction.

Our problem now is that of applying advanced ideas on the economics of railway location to lines already built. We are confined, as a rule, to local changes in alignment which will reduce distance, curvature or rise and fall, but should extend this where practicable to a reduction of the ruling grade.

A recent study was made of the savings that would result from the reduction of ruling grade from 1.4 to 0.3 per cent on an engine district of 104 miles, with about 14,000 tons of freight each way daily, handled by 2: 10: 2 locomotives of 77,000-lb. tractive power in an average of nine freight trains each way, and with five passenger trains each way daily. The result showed that it would be economy to spend $950,000 for each 0.1 per cent reduction in ruling grade, and $220,000 for each mile of distance eliminated by relocation. Thus, each 0.1 per cent of reduction in ruling grade was equivalent to shortening the line 4.32 miles; or the reduction from 1.40 to 0.3 per cent would be equivalent to shortening the engine district 47.5 miles. With double or triple the above amount of traffic the railroad could afford to pay two or three times the expenditures for each 0.1 per cent in reduction of ruling grade.

Grade Reduction Saving Compared with Other Saving—With increase in traffic we have given our attention to improvements in motive power and in track structure, and comparatively little has been done in grade reduction. For single-track lines, there is an opportunity to reduce the ruling grade in the construction of the second track. But many of the older roads had additional main tracks built before the value of a lighter ruling grade was appreciated. In such cases, grade reduction means practically the rebuilding of the lines, and the combined expense and interruption to traffic have prevented much of such work from being carried out. Railroads are spending large sums of money for improvements in superstructures that will facilitate the handling of traffic and effect a saving in time. But the expenditures for grading in a reduction of ruling grade is made but once and carries only an interest charge on the investment, while the expenditures on superstructure improvements carry interest, depreciation and maintenance charges.

We are apt to look with much favor on revision of alignment that will reduce distance, as distance is the "bugaboo" in the operating official's mind, but seldom does such an official consider the comparative rate of ruling grade or the comparative amount of curvature on any two lines. That the importance of these two features is beginning to be appreciated is shown in some recent construction work. For instance, the Castleton cutoff on the New York Central R.R. has a ruling grade of 0.35 per cent; the new line of the Illinois Central R.R. to the Ohio River has a ruling grade of 0.3 per cent and a maximum curvature of 1 deg., while a change of line on the Chicago, Burlington & Quincy R.R. in Illinois has a ruling grade of 0.3 per cent, or 0.25 per cent on the long grades. In reducing the ruling grade from 1 per cent to 0.40 per cent on the Santa Fé Ry. they figured that they could afford to pay $1,000,000 for each 0.1 per cent reduction, which is very close to my figure of $950,000, as given above.

Maintenance cost of track and equipment is increased very materially with the degree of curvature. On an engine district with 100-lb. rail and 2: 8: 2 locomotives of 57,000-lb. tractive power, it was found that in the 10-year period between general rail renewals, rails on 4-deg curves were renewed twice; once or twice on 3-deg. curves, once on 2-deg. curves, and not at all on a 1-deg. curve. In addition, the regaging on account of rail wear weakened the ties materially on the 4-deg. curve, while surfacing had to be done two or three times a year on the 4-deg. curves, as compared with once for those of 1 deg.

In shipping, the time of transportation from the factory or farm to destination is an important feature. It has been found that by increasing the speed of transportation the merchants could reduce stocks of goods materially; this means a smaller investment and more rapid turnover of capital. By the reduction of ruling grade and degree of curvature on trunk lines, heavy trains can be moved at a greater speed with equal safety and with less wear and tear on equipment and track. Thus such reductions will result in reducing both cost and time of transportation.

Akron Trickling Filters Will Use 223,000 Cu.Yd. of Limestone

By J. E. Root
Sewerage Engineer, Department of Public Service, Akron, Ohio

APPROXIMATELY 223,000 cu.yd. of broken limestone at a contract price of $1.85 a ton or about $2.53 a cubic yard will be used in the 14 acres of 10-ft. trickling filters, which, with Imhoff tanks, will be the main features in the new sewage-works for Akron, Ohio. The design is based on an average of 33 m.g.d. sewage flow from an estimated future population of 260,000. The size of the stone will range from 1 to 2½ in.

Before deciding on limestone a careful study of available filtering materials within a reasonable distance of Akron was made by the city officials as well as by their advisory engineers, Metcalf & Eddy. The leading limestone quarries in northwestern Ohio and the large slag plants in the Youngstown district were personally inspected and materials from these quarries and plants carefully considered. In addition, a study was made of the four acres of slag trickling filters which Akron has had in operation since January, 1917, treating Imhoff effluent, as will the new filters.

After the results of all the investigations, including tests of the stone and slag available, and upon the recommendation of the consulting engineers, the material to be used for the new filters was limited to a hard limestone rock to meet the following physical requirements: (1) Hardness, not less than 14 per cent. (2) Toughness, not less than 5. (3) Wear, not more than 6. (4) The stone shall show no signs of checking, cracking or disintegration after 20 successive treatments by the sodium sulphate test. The tests for hardness, toughness and wear follow the standard method for testing stone as a material for road construction.

Six proposals for filtering material were received by the city on Jan. 28, 1926, as follows:

Botzum Brothers, Akron, Ohio (Dolomite Products Co.'s quarry, Narlo, Ohio), $1.80 per ton.
W. F. Wright Co., Akron, Ohio (miscellaneous quarries), $1.85 per cu.yd.
Wagner Quarries Co., Sandusky, Ohio, $1.85 per ton.
Bluffton-Lewisburg Stone Co., Lima, Ohio, $1.87 per ton.
The France Stone Co., Toledo, Ohio, $1.90 per ton.
J. B. Loomis Co., Akron, Ohio, $2 per ton.

Material from the quarries of the first three bidders was subjected to the tests provided in the specifications, after which the contract was awarded to the Wagner Quarries Co.

Tunneling Dry Sand Made "Live" By Passing Trains

Steel Poling Boards and Lagging Give Sand-Tight Excavation—Device of Hanging Arch Keeps Lining Close to Face

COARSE dry sand underneath railway tracks where the jar of passing trains kept it "live" was rather speedily tunneled on recent sewer work in Brooklyn, New York, by using steel "timbering" and keeping the lining close up to the face.

The method is diagrammed in Fig. 1, where ahead is shown the lining plates or lagging held by pipe and trench-jack braces, the suspended arch, the heading and following bench cut and the invert arch. Poling and breast boards were used in advancing the face with no unusual features except the poling boards were steel.

The tunnel is circular in section, 13½ ft. in diameter to the inside of the 16-in. lining, which is concrete in the arch and concrete with a wearing course of brick in the invert. The tunnel is being built in connection with a large repair contract on an existing sewer. While it has been planned to do the major part of the repair work in open cut, railroad tracks and a highway bridge over them will make work within the existing sewer necessary for several hundred feet. The tunnel being constructed is a bypass for carrying the sewage flow while this work inside the old sewer is going on. The location of the tunnel is shown in Fig. 2. It is about 350 ft. long and contains one sharp curve where special wooden-templet concreting forms and beveled liner plates have replaced the steel forms and rectangular liner plates. The soil is a coarse dry sand and is used as concrete aggregate.

General Procedure—The tunnel is being driven by advancing an upper heading of half the sewer section, following with the invert excavation. Two sets each of arch forms and invert forms are used. Each set is 12 ft. long, made up of plates held in position by ribs of 6-in. 15-lb. ship channels placed on 3-ft. centers. All concrete is shoveled into the forms. Transportation of concrete and spoil for the arch and invert is on two track levels.

The arch heading is usually about 30 ft. ahead of the invert excavation, Fig. 1. Sections of concreted arch are doweled together and further support for the undermined length of the arch is provided by staggering the joints of the arch and invert. In starting the tunnel 24 ft. of arch was excavated and concreted in 12-ft. sections followed by a 6-ft. length of invert. Then excavation of the arch heading was advanced 12 ft. and

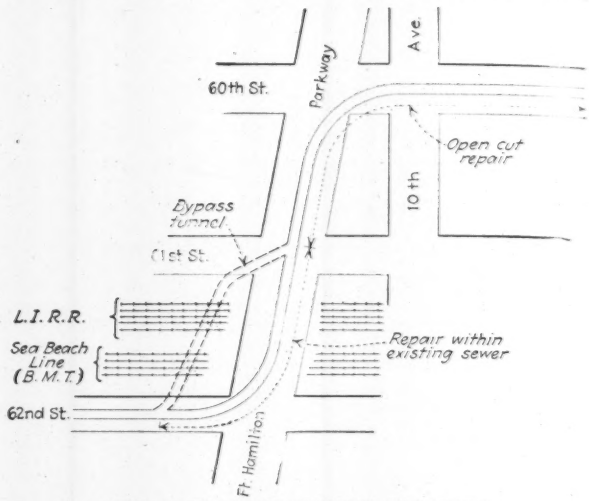


FIG. 2—PLAN OF TUNNEL LOCATION

one set of forms moved up. Excavation of a 12-ft. section of invert and the placing of the forms followed There was thus ready a section of arch and a section of invert for the concreting gang. A maximum of 12 ft. of concreted arch is overhanging supports at any one time—6 ft. ahead of the completed invert and 6 ft. back from the unexcavated bench Fig. 1. The tunnel construction operations then are divided among the three shifts of workmen as follows: First shift excavates 12 ft. of arch heading; second shift places arch forms besides excavating and placing the forms in the invert; third shift concretes arch and invert. There is, of course some overlapping of duties but this represents substantially the sequence followed. It has made possible an average advance of 36 ft. of completed sewer per week of 6 days.

Work at the Face—Excavation of the arch heading is necessarily piecemeal on account of the loose soil whose instability is increased by vibration from overhead train movements. The face bulkhead is therefore removed a board at a time. The construction of this bulkhead is usual, consisting in this case of ¼-in. "slivers" placed vertically on about 3-in. centers, behind which are straw packing and 1-in. breast boards placed horizontally.

Three miners are used for excavating, one at the top

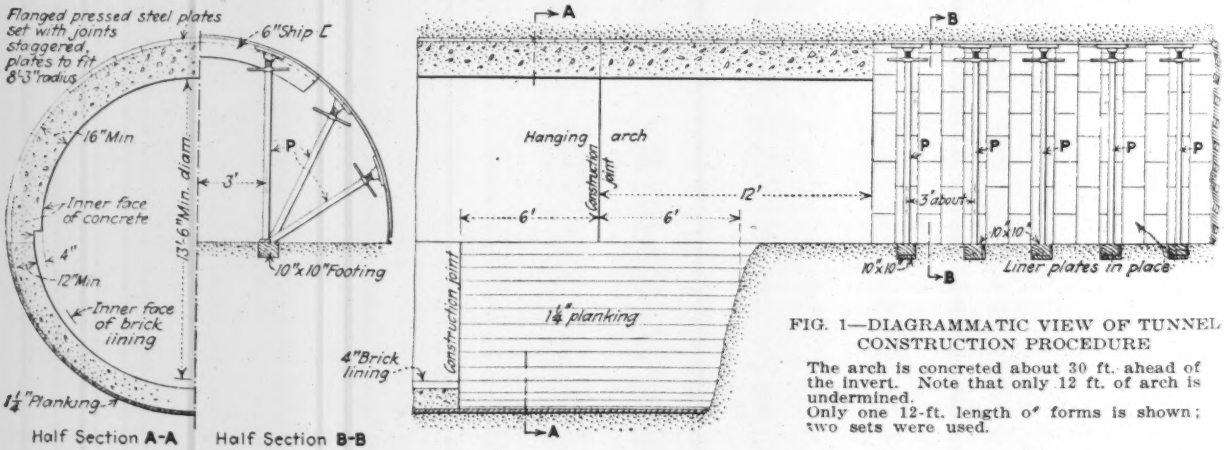


FIG. 1—DIAGRAMMATIC VIEW OF TUNNEL CONSTRUCTION PROCEDURE

The arch is concreted about 30 ft. ahead of the invert. Note that only 12 ft. of arch is undermined.
Only one 12-ft. length of forms is shown; two sets were used.

and one at either side near the bottom. The man at the top keeps several feet in advance of the others. As fast as the excavation is opened the flanged steel liner

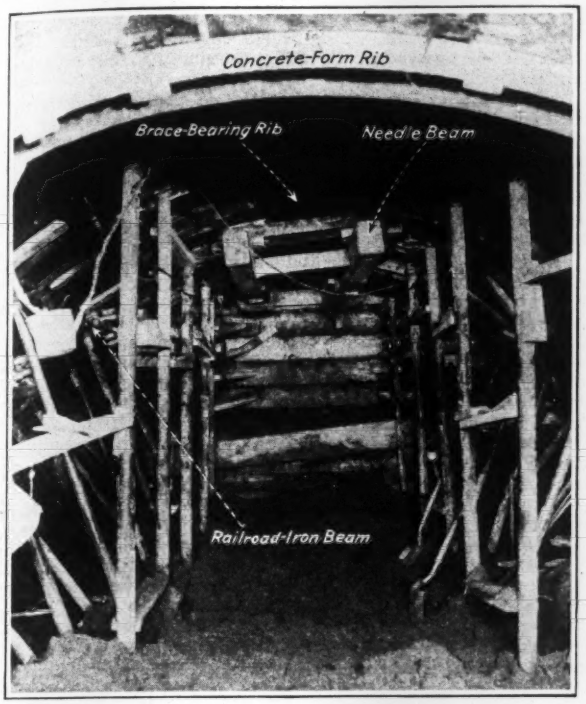


FIG. 3—LINER PLATE SHORING SYSTEM AT ARCH HEADING FACE

Note that three pipe shores diverge from each footing. View taken just prior to moving a 12-ft. section of concreting forms ahead. End of concrete forms is seen in upper foreground.

plates 16 in. wide and 3 ft. long of 11 gage metal are set and bolted.

In advancing the top of the arch heading, steel poling boards of ⅞-in. plate 6 in. wide by 30 in. long are used. An angle is bolted 3 in. from the end of each poling board and a bar or shovel hit against this advances the board. The miner removes the topmost breast board, drives his poling boards and places a liner plate. This plate is blocked up by a short piece of pipe until a further advance permits a second plate to be inserted. This constitutes the longitudinal advance, the same procedure being used for a distance of 3 or 4 ft. down on either side until a brace-bearing rib, Fig. 3, can be placed to support the liner plates in the top of the arch. In advancing the heading the steel poling boards can be used for only about 10 ft. of the circumference at the top as they slide down when used on the sides. Here wooden poling boards are used.

The brace-bearing ribs consist of 6-in. ship channels 8 ft. long bent to the required radius and placed on about 3-ft. centers. A needle beam of a 6x8-in. timber 10 ft. long hung from U-hangers fastened to the last rib placed is driven forward to carry the new rib until the bench can be excavated to the bottom. As soon as this is accomplished trench jacks inserted in long pipes are placed under the rib and the needle beam removed. These pipe shores are about 6 ft. apart and provide room between them for the industrial track.

A useful detail on the brace-bearing rib is the punching of holes in the flanges of the channels on 6-in. centers; through these holes (Fig. 3) the U-hangers holding the needle beam are supported, also bolts are inserted through them on either side of the bearing of the jacks to keep them from kicking out sideways.

The miners at the sides also place a plate at a time. The plates are braced with diagonal shores as in Fig. 3. All shores in a set, one vertical and two diagonal, rest on the same footing of short heavy planking. To give the same temporary support to the side liner plates that the needle beam gives to the plates in the top of the arch, an 8 ft. length of railroad iron is used as a beam, its supports being the wing nut handles of the pipe shores. A simple method used to keep the liner plates in position is to drive small wooden wedges between the flanges several feet back of the face. This serves to guide the front plates up or down as required and a radius variation of about 6 in. is thus possible.

The brace-bearing ribs held up by the vertical pipe shores are placed on every other row of liner plates so as to clear the arch ribs of the concrete forms which are spaced on 3-ft. centers. Concreting starts at the bottom of the arch and as the plates are added the braces are removed. For spacers, three short pieces of concrete-filled pipe are used over each form rib bracing the liner plates away from the form plates; one of these pipes is placed at the top of the arch and the others about 5 ft. down on either side.

In general, the usual design of concreting forms is used. However, for receiving the top course of invert concrete which seals the invert to the already concreted

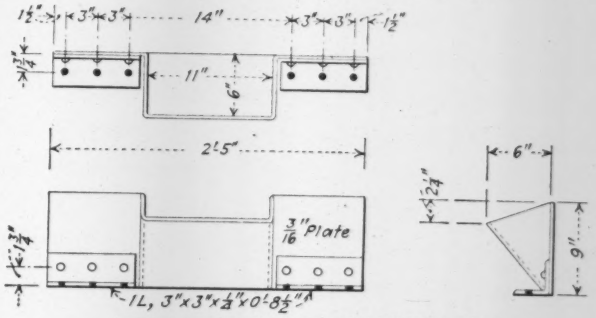


FIG. 4—DETAIL OF TROUGH PLATE

Used to place seal concrete between invert and arch.

arch a special trough-plate, Fig. 4, has been devised. Concrete is poured into the trough and spaded until it completely fills the opening. It is often necessary to go back and refill some of the troughs since settlement usually takes place. Upon removal of the forms, the benches of concrete formed by the troughs are used temporarily to support beams for the upper track decking until posts footing on the invert concrete may be placed under them. These benches will be knocked off upon completion of the tunnel.

Excavation of the invert presents no difficulties. The sand is so loose that a bulkhead is driven down 12 ft. ahead of the face and excavation is carried up to this point by merely loading the material into the cars. The liner plates are carried only about 3 ft. below the spring line, the concrete being poured on planking for the remainder of the invert.

Direction—The contractor carrying on the sewer repair work of which the tunnel driving is a major operation is the Montrose Contracting Co., New York City, with Harry Redwood as superintendent on the job. The work is under the supervision of the Brooklyn Bureau of Sewers, Arthur J. Griffin, chief engineer.

Denver Societies Hold Money Wasted on Flood Control Work

Serious Indictment of Official Expenditures Without Previous Comprehensive Studies by Competent Engineers

FOURTEEN engineering and technical societies, comprising the Colorado Engineering Council, after serious and extended consideration for many months on the problem of the control of floods in Denver, have brought in a report which censures the city administration severely for waste of money in building embankments which are "not of a sufficiently substantial nature to insure the safe carrying capacity that otherwise would be possible with the levee heights adopted."

Further, the report states that there is a serious flood menace in Denver, worthy of a careful and comprehensive study, but no such study has been made. The present work is called inadequate to protect life and property and there is no assurance that it will coordinate with an adequate plan when made. The policy of the administration regarding removal of obstructions and acquiring title to property located in the present streambed is commended. The following notes are taken from the report:

Present Procedure—The scheme on which the city administration is now working is based on an ordinance passed in 1911, which defined the width of South Platte River as 150 ft. above the mouth of Cherry Creek and 200 ft. below. It appears that these identical dimensions were established by the city authorities as the official channel widths of the South Platte about forty years ago, their basis being merely a guess, with no study of possible floods and with no actual protection experience. A flow depth of 10 ft. has been adopted, which is based on the fact that along the lower part of the river the banks, which are well defined, have a height of about 10 ft., and were not overflowed by the flood of 1912. In providing clear channel widths of 150 and 200 ft., respectively, it is the intention to remove all pile-bent bridges as fast as funds for new bridges become available and to change the river channel where necessary, particularly in the north end of the city. It is also the intention to remove the old water company's dam and the Mullens dam, as soon as the proper arrangements can be made. C. D. Vail, manager of improvements and parks, believes that any additional flood protection which may later be considered necessary can best be obtained by the construction of works outside the city, and that the present city plans will fit in with any later plan so selected.

The average fall of the river through the city is about 11 ft. per mile. Your committee, using the Kutter formula with a roughness factor of 0.030 (which it advises) and considering the channels as rectangular with the above stated dimensions and with all obstructions removed, computes the capacity of the channel above the mouth of Cherry Creek as 14,700 sec.-ft., and that of the channel below Cherry Creek as 20,000 sec.-ft.

The budget for the year 1925 carried $100,000 for beginning the channel improvement work. Of this amount $66,280 was expended up to Nov. 1, not including the cost of the new Third Ave. bridge, which amounted to $42,000 and which came out of another fund. This bridge appears to have been well designed and constructed. The piers are placed parallel with the direction of flow and offer but little obstruction to the passage of floods, while the general construction is such that the superstructure can be raised or spans added if later found necessary.

The city's flood improvement work has been started between West Third and West Thirteenth Aves. where levees are being constructed of sand and dredged from the river bed and deposited on brush piled along the right bank, and where some stone-masonry retaining walls and slope paving have been constructed. The sand used in the levee construction is believed by the city officials to contain sufficient silt to make the embankment watertight. The brush was placed under the levee toe to prevent scour, although it was realized that riprapping the slopes would be advisable at some future time. The retaining walls were carried down to depths of from 3 to 4 ft. below low water and were built chiefly of old curbstones. Their cost amounted to approximately $12 per running foot of bank length.

Your committee believes that the bank-protection work being constructed is not of a sufficiently substantial or durable character to insure the safe carriage of the calculated flood flows given above. During such floods the average velocities in the improved channels will be about 10 ft. per second. Experience shows that with such velocities material like that existing in the bed of the South Platte channel will be moving along the bottom to depths of several feet, so that undermining of the revetment foundations undoubtedly will take place.

It is the intention of the city administration to continue the work along other sections of the South Platte as further appropriations are made, excavating new channels where necessary and improving the most dangerous sections of the channel first. An appropriation of $150,000 is available for carrying on the work in 1926. The city is also acquiring, as rapidly as possible, legal title to the land occupied by the streambeds. The fact that private parties have held these titles has been one of the troublesome factors connected with the prosecution of the work. It is understood that only small sums of money have been expended in acquiring right-of-way, that in many instances, especially in the case of the larger industrial concerns, the right-of-way needed has been donated, and that if it is found necessary to acquire any very valuable tracts the money will be taken from another fund.

Denver's Flood Menace—The greatest flood at Denver during the 30 years for which reliable records are available had a peak discharge of 13,000 sec.-ft. of which 12,000 sec.-ft. came from Cherry Creek, which drains 421 sq. miles. This was the flood of July 14, 1912. The next largest flood, that of June 8, 1921, had a maximum discharge of 8,790 sec.-ft., more than 75 per cent of which originated in the South Platte basin above Cherry Creek (area 3,420 sq. miles). It can thus be shown that no floods of very great magnitude have occurred in either Cherry Creek or South Platte River during the past 30 years. Furthermore, it has been established by indirect means that no flood comparable with the 1912 flood has occurred at least since 1876, when a flood of considerable magnitude occurred. So it may be safely stated that the 1912 flood was the largest in the last 50 years.

All of the Cherry Creek drainage basin and approximately 420 square miles of the South Platte drainage area above Cherry Creek lie just east of the mountains, in an area noted for the frequency and intensity of its cloudburst rainfall. The reason these particular areas have not experienced severe floods recently is that the most intense cloudbursts, such as those that occurred near Pueble in June, 1921, and the ones that occurred in the Salt Creek basin of central Wyoming in 1923, have happened to fall elsewhere. On Sept. 28, 1923, cloudbursts in the Salt Creek basin of Wyoming caused a flood of 32,000 sec.-ft. in Salt Creek, a rate of approximately 61 sec.-ft. per square mile, or twice that of the flood of July, 1912, at Denver. During the June, 1921, floods in the Arkansas River valley, the St. Charles River, a tributary of the Arkansas below Pueblo, with a drainage area only 15 per cent larger than that drained by Cherry Creek, discharged a computed peak flow of approximately 72,000 sec.-ft., a rate of about 150 sec.-ft. per square mile, or about five times as great as the Cherry Creek flood of July, 1912.

Whether rates of flood runoff as great as those that occurred near Pueblo in 1921, or greater, can occur simultaneously over the Cherry Creek valley and the plains portion of the South Platte drainage area above Denver, rests on the theory of probability. It seems reasonably certain that such rates cannot occur over areas of very great size located in the mountainous part of the drainage basin. Practically all of the 1921 flood at Pueblo, which reached a maximum discharge of 103,000 sec.-ft., came from a drainage area of approximately 550 sq. miles lying east of the mountains. To assume that similar rates of rainfall and runoff cannot take place over the plains area above Denver would not be warranted with our present knowledge of

meteorological conditions as affecting cloudburst occurrence. In fact the Cherry Creek Flood Commission in 1913, eight years before the Pueblo flood, concluded that a maximum flood discharge of 60,000 sec.-ft. in Cherry Creek was not only possible but even probable.

The most conservative reasoning, based on flood data now available, would indicate that some day Denver will experience a flood several times as great as the maximum recorded in the past—a flood several times as great as can be carried in channels such as the city officials now propose to construct, even though the levee and slope-protection structures were of a stable character. Such a flood may not visit Denver for a hundred years. Then again it may come next year. How great a loss of life and property it will cause when it finally arrives, if adequate flood-control measures are not effected, can hardly be estimated. We know it will be appalling. Seventy-eight bodies were recovered after the Pueblo flood of June, 1921; while the property loss was estimated at $19,000,000.

Inadequacy of the Present Procedure—Your committee is convinced that the present flood-control procedure being executed by the city administration is inadequate to protect life and property in Denver from the flood hazard. While no exact statements can be made at this time regarding the size of the maximum flood to be expected in South Platte River, the brief discussion just presented shows that a flood much greater than the one provided for is likely to occur in the future. How much greater can only be forecast after a careful and extensive study of existing flood data for localities of similar topographic and meteorological conditions. Such a study has not, thus far, been made. It should also be pointed out that the present scheme applies only to the South Platte channel, no works being considered for the control of floods in Cherry Creek.

Your committee feels that while some of the activities included in the present program are to be commended, the general policy of proceeding with the expenditure of funds for costly flood-control improvements without a comprehensive study of the whole problem and without a determination of how the works to be constructed will fulfill their purpose and how they will co-ordinate with an adequate plan which may be found advisable later, cannot be approved. It is contrary to all economic and engineering principles to proceed with the expenditure of funds for works of any character without first determining their adequacy and fitness for the purpose intended. There is no evidence or data indicating that a study of the South Platte flood control problem has ever been made, and there has been no study of the Cherry Creek flood control problem since 1913, notwithstanding the fact that during the last few years the knowledge of flood probabilities and the science of flood-protection work have made great advances.

It may, or may not, be economically feasible to construct adequate flood-control works for Denver at this time. However, the citizens and taxpayers whose lives and property are at stake are entitled to know whether or not such works are feasible. They are entitled to know in what manner protection can be obtained and what it will probably cost. Then they can decide whether the construction of adequate works should be undertaken. If the decision is to postpone the execution of an adequate plan, the city administration will have fulfilled its duty to the people. Moreover, the city officials will have an adequate plan available toward which they can work as money for partial protection is appropriated.

Recommendations—1. A comprehensive engineering study of Denver's flood problems and the development of an adequate plan for the protection of life and property from the flood menace should be made without delay, by competent hydraulic engineers, experienced in flood protection work.

2. The work of improving the South Platte River by enlarging the present channel, excavating new channels in places, building new levees and constructing bank protection should be deferred until such engineering investigation has been made and an adequate and comprehensive plan for flood control for both Cherry Creek and the South Platte River is made available.

3. The removal of channel obstructions should be continued for the present according to the program adopted by the city officials, the program to be modified later, when and if found advisable in the engineering investigation.

4. The policy of the city administration regarding the acquiring of title to property in the streambeds should be continued for the present.

This report, which was adopted March 2, was taken up with city officials March 25 who held that the money was being well spent, that conditions would be better and that any future work would fit in well with the present construction. Since special objection was made to recommendation 2 noted above, it was referred back to the Council which, on April 14, sustained its original position.

Colorado Engineering Council is made up of one representative and one alternate member from each of the fourteen engineering bodies in the Council. On April 15 the Colorado section of the American Society of Civil Engineers, which is one member of the Council, also adopted a similar report.

Track Construction in Paved Streets

RESULTS of a questionnaire sent out by the Committee on Track of the American Railway Engineering Association on the use of girder and T-rails in paved streets are given in the committee's annual report, in bulletin 283 of the association. The particulars as to this type of construction, as summarized below, relate only to steam railway tracks, such as those leading to docks and warehouses. The committees on Track and on Rails have co-operated in preparing standard designs for grooved-girder rails for track of this type.

Grooved-girder rails used on 68 miles of track are mainly of 9-in. 141-lb. section, with some 159-lb. 9-in. and 127-lb. 7-in. rails. They are in various lengths, 30 to 66 ft., the greatest tonnage being in 33-ft. rails. Splice bars 22 to 36 in. long have from four to twelve bolts. Ties are usually 7x9 in., 8 or 8½ ft. long, of treated yellow pine, spaced approximately 22½ in. c. to c. Tie-plates are in general use; also tierods spaced about 5 ft. c. to c. Brace plates are sometime used instead of tierods. Crushed stone or concrete is placed under the ties and the paving is generally of stone blocks, but asphalt, concrete, brick, bituminous concrete and wood block are also used. Girder guard rail is used to a very limited extent and only opposite frogs and on the inner rail of curves. Girder rail should be used in permanent low-speed tracks which require paving. Vertical stiffness is the most important factor in determining the height of girder rail to be used.

Ordinary T-rails should be used only when the street contruction is not of permanent character and the rail traffic is exceedingly light; otherwise the cost of maintenance would be excessive. On 119-miles of T-rail paved track, about 100 miles are of various sections and the others of 60 to 90-lb. A.S.C.E. section. The length is usually 33 ft.; one road uses 60 ft. and another is planning to use 39 ft. Guard rails are used to a limited extent on the inner side of curves. As to pre-curving rails for curves, the practice is very variable, the minimum curve for such bending on different roads ranging from 2 to 30 deg. Flat tie-plates are generally used, but tie-rods rarely, and only on curves, with a spacing of 10 ft. Various types of paving are used. In concrete, the flangeway may be formed by a templet; in asphaltic compositions, by a hot iron or by the wheel flanges; in stone block paving, by wood block fillers.

Satisfactory results have been obtained from the use of both T-rails and girder rails, but considerable expense is involved in the construction and maintenance of the paving as vibration and movement of the rails under the traffic loads accelerate the disintegration of the paving. To minimize this detrimental effect, the designs of rail sections and joints for this service should embody strength and rigidity. To meet these requirements the committee recommends 159-lb. 9-in. and 128-lb. 7-in. grooved rails, with a 174-lb. 9-in. grooved rail having a heavy guard for use opposite frogs and on the inner rail of curves, where the lift of the outer rail is limited by flange wear rather than by top wear.

Economical Concreting Plant for Tank Construction

Kansas City Water-Works Structures Concreted by Industrial Railway Hauling and Bucket Placing With Crawler Cranes

DISTRIBUTION of 35,000 cu.yd. of concrete to eleven structures covering 14 acres of ground was the problem in tank and basin construction for the new water-works of Kansas City, Mo. (See articles in *Engineering News-Record* March 25, p. 492, and April 8, p. 573.) The structures are: four circular preliminary settling tanks, two circular mixing tanks, three rectangular coagulating basins and two rectangular settling basins. None of the structures is high; the walls are simple batter sections, reinforced, on spread footings; the floors are reinforced slabs laid on the ground. Concrete distribution was the construction problem. The contractor's solution was industrial railway haulage from a central mixing plant and crawler cranes placing the concrete with buckets.

Plant Plan and Equipment—The site had been previously graded and offered no physical obstacles to freedom to use any of several available types of plant. Before adopting railway distribution the contractor considered both a chuting and a cableway plan. Chuting would have required several towers and several distinct plants and so was not considered to any great extent. A cableway, however, was more practical although the tracks for the towers would have to be 900 ft. apart, running in an east-west direction and 1,400 ft. apart in a north-south direction. Furthermore the filters, the pumping station and the chemical building are being built under a separate contract and a cableway would have interfered with this work. In both cases the small amount of concrete (35,000 yd.) was a controlling reason for not adopting chuting and cableways, both of which would have tied up considerable money in plant. Since adopting the industrial track plan the contractor has spent approximately one-third of his estimate for the cableway equipment alone.

The central mixing plant is located on a siding of an electric line over which all materials are brought in. A locomotive crane track as shown in Fig. 1 runs several hundred feet each way from the plant reaching to the storage yards for reinforcing steel and for pipe. These materials are carried back to the plant as needed and transferred to the industrial railway. The crane operating a clamshell bucket also charges the sand and stone bins either direct from railway cars or from the storage piles at either end of the plant.

The plant proper consists of the material bins feeding through volumetric measuring hoppers into two ¾-yd. mixers. Cement is charged from a platform at mixer level. The mixers discharge into a concrete storage hopper beneath so that they can mix continuously without regard to industrial train movements. These, however, are so rapid that no segregation takes place. Winter work provisions consisted of steam coils in the sand and stone bins and the heating of the mixing water. Gasoline locomotives back the trains, usually of three flat cars, under the concrete hopper. Each car carries a 1-yd. concrete bucket.

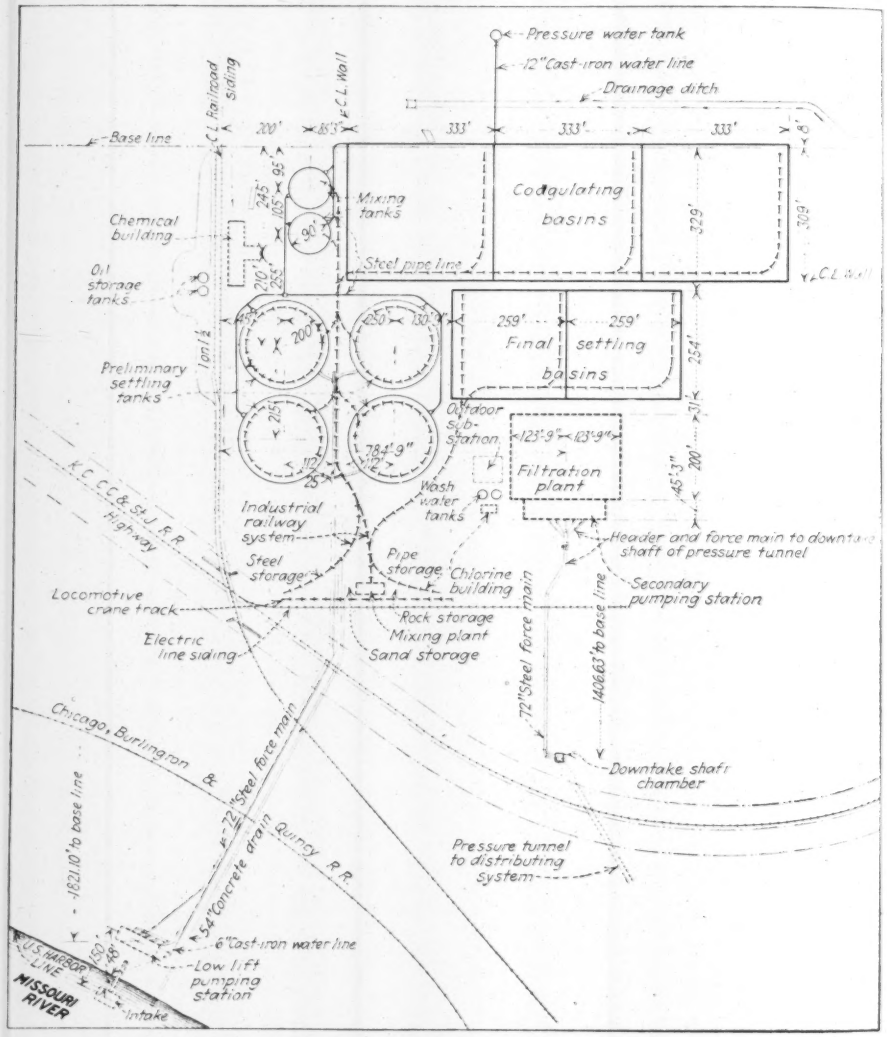


FIG. 1—GENERAL PLAN OF CONSTRUCTION PLANT
The filters, pumping stations, chemical building and intake are not a part of the basin contract.

Constructing Circular Tanks—The complete industrial track system is shown by Fig. 1. This is being placed as construction progresses. The circular preliminary tanks have been constructed first. Each of these is 200 ft. in diameter, the walls being of reinforced concrete 20 in. thick resting on spread footings

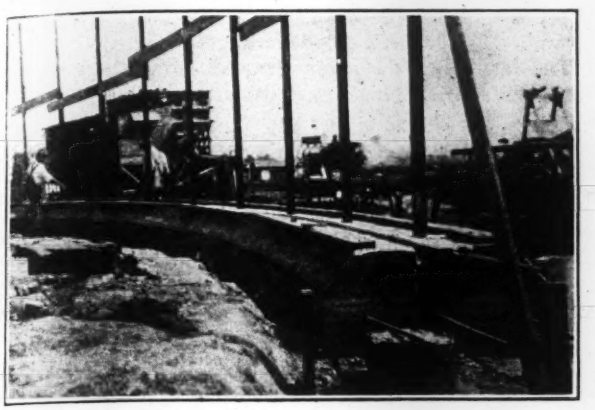


FIG. 2—SPREAD FOOTING FOR CIRCULAR BASINS
Note foundation pile in foreground and central mixing plant in background.

and pile foundations, Fig. 2. The piles are staggered on 5-ft. centers and were driven by a steam hammer. A center pier, which will support the central column of the clarifier, also rests on piles. The floor, a reinforced-concrete slab sloping toward the center, will be supported on puddled clay. The vertical reinforcing steel in the walls was 3-in. 4-lb. channels punched as required to hold the circular bars. These were erected by hand and the wall forms set on the footings which had been previously placed on top of and around the piles.

Industrial track was laid around the inner circumference of the basins, the trains making the complete circle so that uninterrupted pouring of concrete could be followed. A gasoline crane operating on crawlers picked the bottom-dump hoppers from the cars and elevated them to the top of the forms which are 18 ft. high. All concrete was deposited from this height. The walls are poured in about 100-ft. sections, the forms being moved in 20-ft. lengths and reset by the crane.

The construction procedure on the two 90-ft. diameter mixing tanks was similar to that on the preliminary basins except that no track was used inside, the crane boom being long enough to reach all parts of the structure when the crane was placed in the center. A construction opening about 20 ft. wide was left in the wall of all tanks. This will be closed after the floor is poured, but the concrete for the last small section of floor next to the wall will have to be lifted over the wall.

Constructing Rectangular Basins — The coagulation basins, three in number, are 333x309 ft. in plan by 18 ft. deep and have a total capacity of 37½ million gallons. These basins discharge over a weir into the final basins which are 359x254 ft. in plan by 17 ft. deep and have a total capacity of 14½ million gallons. The bottoms of these basins are of a corrugated section to facilitate the bleeding of the sludge.

Much the same construction procedure is used to haul and place the concrete as was used on the preliminary basins. The industrial track will be placed along only two walls of the basins as shown in Fig. 1. In concreting the rear walls of these basins

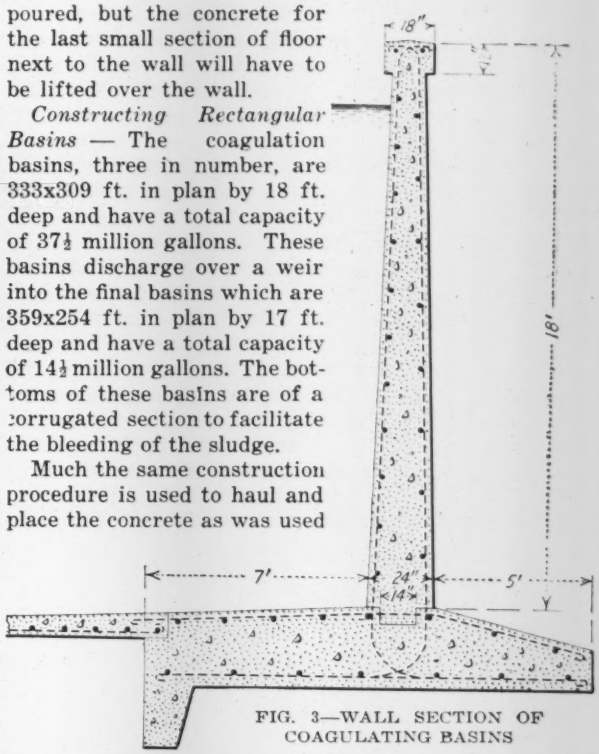


FIG. 3—WALL SECTION OF COAGULATING BASINS

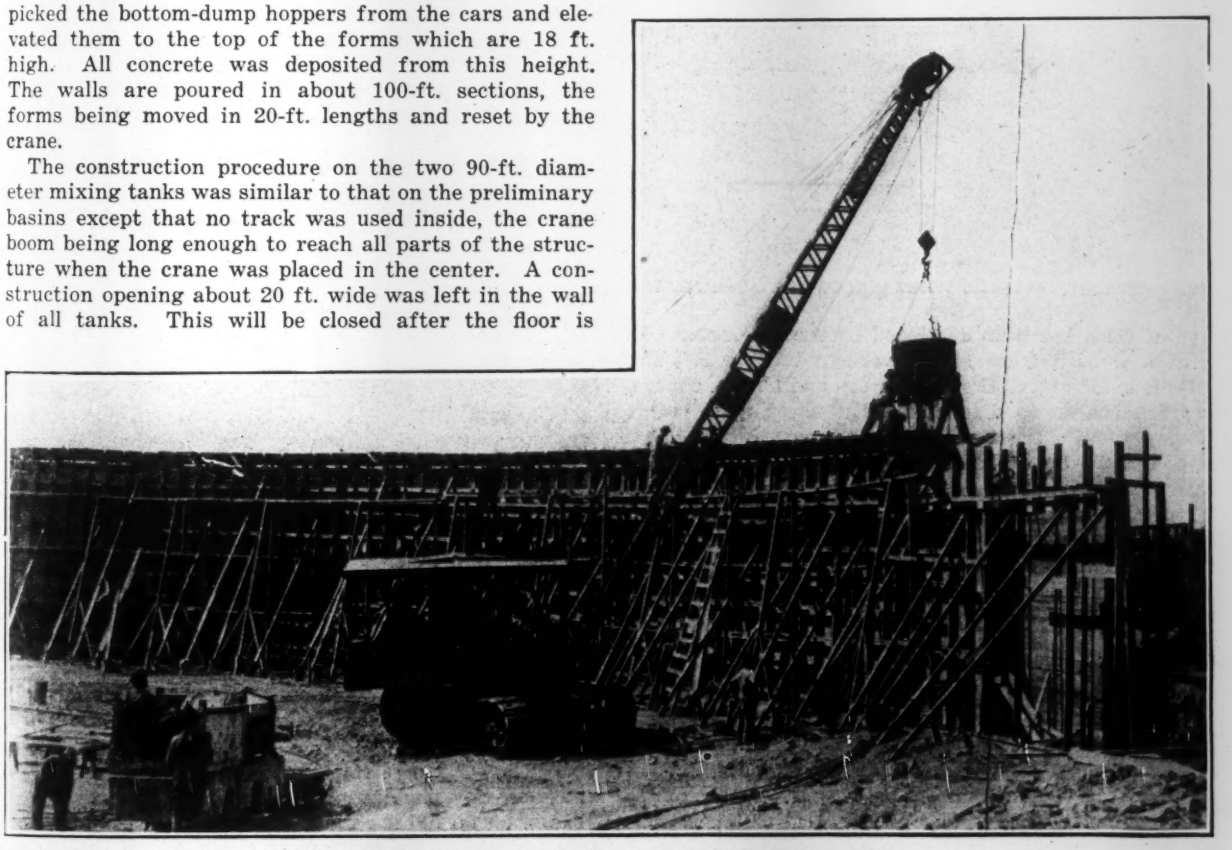


FIG. 4—POURING CONCRETE ON CIRCULAR SETTLING BASINS

which contain the influent channels and sluice gates the plan is to pour a section of the floor as far as an expantion joint and then follow by the same amount of wall, moving the industrial track to the left as each section is completed. The floor must be poured first as it keys under the walls; the east, west and division walls are under the floor and can thus be poured first, Fig. 3. It will be noted that the steel in the east, west and division walls of all the rectangular basins is continuous from the footings to the top of the wall. This steel was set at the time the footings were poured, supported at the bottom by spacers and again about 10 ft. above the ground by a wooden templet.

Pouring concrete has been pursued in the same manner as on the circular basins, Fig. 4, but a different

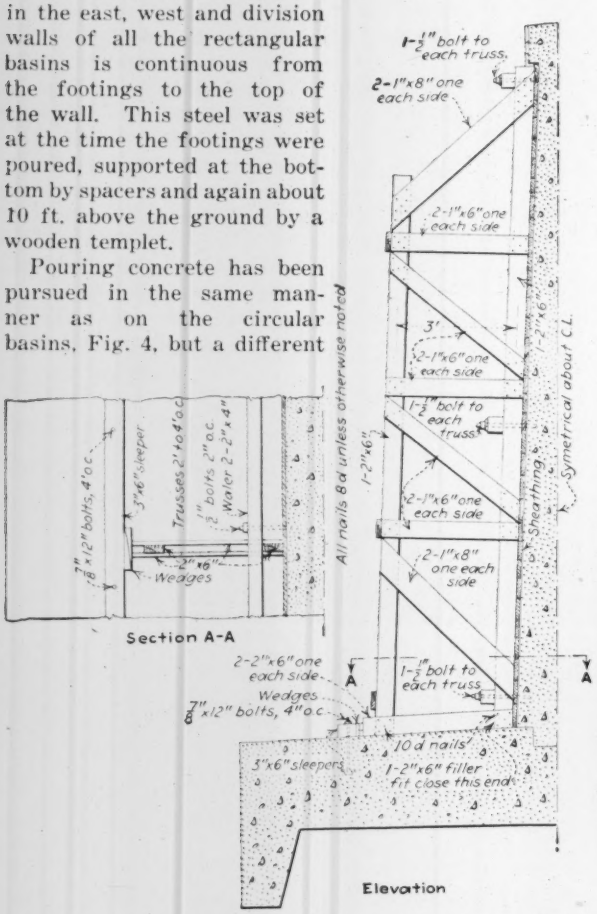


FIG. 5—DETAIL OF WALL FORM FOR COAGULATING BASIN

type of form has been developed by the contractor. It is of a wooden truss section, shown in Fig. 5. The truss is made of 2x6 timbers for top and bottom chords, and 1x8 boards as diagonals. The sheeting is nailed to the bottom chord and sections are constructed 12 ft. long, either 3 or 4 trusses being used per section. The truss was designed to eliminate the expense and trouble of putting bolts through the walls as was done on the preliminary basins. Three rows of longitudinal waling are used and bolts are put through the walls at these points. The rest of the load from the concrete is taken to the abutment of the truss and into the footing. When the footing is poured, ⅞-in. bolts, 12 in. long, are placed on 4-ft. centers. A 3x6 sleeper is bolted over these bolts and the truss anchored as shown. No bolts are used in the trusses, all joints being nailed. A section 72 ft. long is poured at a time. The forms are moved by sliding them along the footing, the gasoline locomotives moving the entire form as a unit. The bolts are finally cut off and the holes grouted. Final operations will consist in filling the entire area to within about 1 ft. of the top of the basins on the outside. This will mean a 10- to 20-ft. fill over about 6 acres of land.

The James Black Masonry & Contracting Co., Omaha, Neb., with C. D. Whitmire as general manager, has the contract for the basins. Fuller & Maitland, Kansas City, Mo., are the designing engineers of the new Kansas City water-works system.

Old Iron Bridge Transformed to Masonry Arch Viaduct

Special Method Developed for Rebuilding Under Traffic—Floor Transferred to Arch Before Removing Girders

By Frank H. Constant
Professor of Civil Engineering, Princeton University, Princeton, N. J.

THE main railway line from Lausanne to Paris crosses the river Orbe, about 1½ miles east of Vallorbe, the Swiss station on the French frontier, on a high viaduct. The old bridge, constructed in 1867-69, was a three-span wrought-iron continuous lattice-girder structure supported on two high intermediate stone

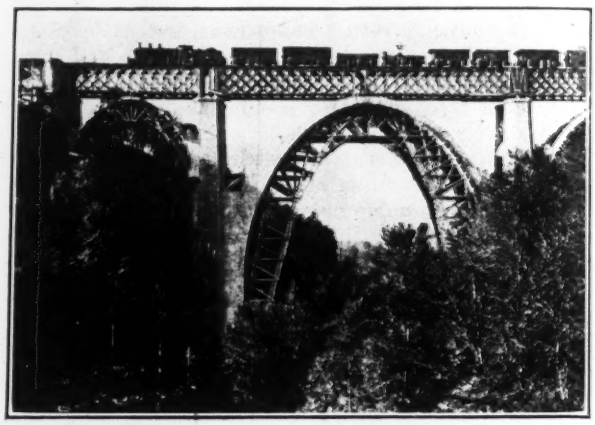


FIG. 1—ARCH RINGS READY TO TAKE LOAD

piers and end abutments. It was originally designed for two tracks but was operated single-track for thirty-seven years. In 1906, when the second track was laid, it was necessary to strengthen the bridge for the increase in train loading. This was accomplished by the simple expedient (used frequently in Switzerland) of stretching a tension member, or "hog chain," below the girders (Fig. 2). This was attached to the lower chord at the ends of the span, and braced to the latter at intervals by one or more vertical struts. Some slight reinforcement of the web at the ends of the span was inserted, but in general both the bending and the shearing stresses in the girder were reduced by this system of reinforcement.

Recently, with the electrification of the line and still further increase in live-loading, it was decided to replace the metal structure by a masonry one, utilizing the old abutments and the two high piers. This was done under traffic, by a most interesting plan of working. The successive steps in the execution of the work are shown by photographs herewith.

In order to lighten the old structure and permit the safe removal of the reinforcing chain, one of the tracks

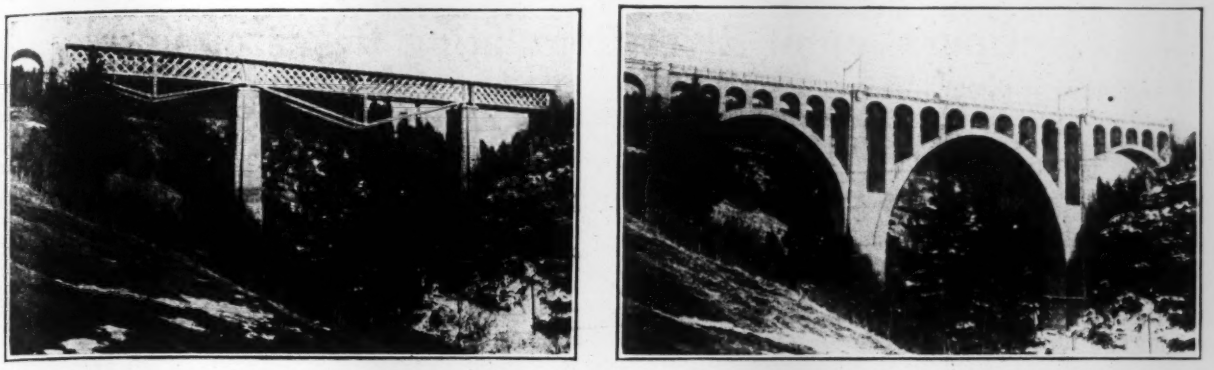


FIG. 2—OLD IRON VIADUCT AT VALLORBE, SWITZERLAND—ITS MASONRY SUCCESSOR CONSTRUCTED UNDER TRAFFIC

was taken up, and the other moved to the center line of the bridge. Skewback seats for the arches were cut at the base of the piers, and the new masonry arches and the spandrel columns where then built up to the underside of the old girders. (Fig. 1).

The three main arches have clear spans of 30, 44 and 19 m. respectively, at the springing planes; and the middle span has a rise, from springing plane to the underside of the arch at the crown, of 31.19 m. The total height from the bottom of the valley under the center arch to track grade is 58.44 m. (195 ft.).

The system of centering used is clearly shown in Fig. 1. The Swiss use round timbers to a considerable extent in falsework, partly for economy and partly for strength. The centering was struck by sawing certain timbers near the quarter points, which permitted a slight movement of the remaining ones. This system has been used with several other recent Swiss bridges.

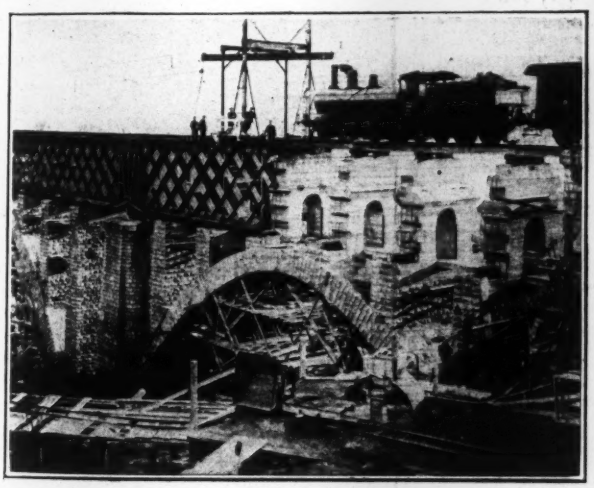


FIG. 3—TRANSFERRING FLOOR TO SPANDREL PIERS

From this point the following steps in the construction were followed consecutively:

The iron girders were supported upon the spandrel piers by means of wooden blocks; the spandrel piers were then continued up between the girders nearly to the elevation of the bottom of the stringers (Fig. 3). This part was cast in concrete. The stringers and floorbeams were removed and replaced by four lines of temporary steel I-beams supported upon wooden blocks over the spandrel piers. The rails rested upon wooden blocks placed upon the inside lower flanges of two adjacent lines of the I-beams. All of the beams and blocks were securely held together by the use of long separator bolts. Horizontal lateral bracing between the top flanges of the inside lines of beams further secured the alignment and stiffness of the track at this stage. From 10 to 40 m. of track were relaid between trains.

The iron girders could now be removed, section by section. With the girders out of the way the spandrel piers were enlarged to their full width and the small spandrel arches constructed. Finally the construction

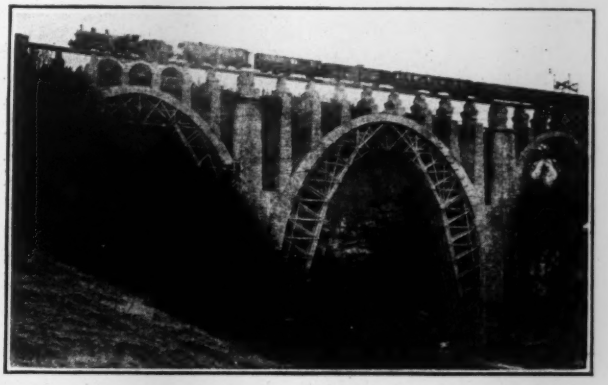


FIG. 4—NEW STRUCTURE READY FOR COMPLETING

was completed by filling in the space above the spandrel arches with lean concrete, placing the permanent substructure for the tracks, removing the blocking as the work progressed, and relaying the double track in accordance with the original alignment.

All the work was conducted without serious interruption of the traffic on this most important line. The bridge was completed in June of 1925. The total cost was about 1,150,000 Swiss francs, of which about 100,000 f. were for the arch centering. The volume of the completed structure is about 19,000 cu.m., of which 10,000 cu.m. are new and 9,000 cu.m. are old masonry.

The Vallorbe viaduct was reconstructed according to the plans and under the general direction of A. Bühler, of Berne, chief bridge engineer of the Swiss Federal Ry., through whose courtesy the writer was supplied with the complete plans of the bridge and enabled to inspect the work during its construction. M. Chapuis was the resident engineer in charge. The contractors were Bollini and Chiavazza of Baulmes.

Operation of River Regulating Reservoirs

Possibilities of Storage Reservoirs Studied by the Use of Mass Diagrams Made From Flow Records—Regulation Adjusted to Meet Local Requirements

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THE PURPOSE of a regulating reservoir is to smooth out the irregularities in the natural discharge of a stream by retarding its flow during flood periods and increasing it during dry periods. The excess flow in time of high water is stored in the reservoir for release when desired. The degree of regulation possible depends upon the location of the reservoir and its capacity. Hence at any particular dam site on a given stream it depends upon the height of the dam. In studies for determining both the proper location and height of dam the most satisfactory method of investigating the possibilities of the stream is to plot a mass curve of the cumulative flow for a long period from actual chronological discharge records of past years if such data are available. If such records do not exist recourse must be had to theoretical prophesies based on whatever data can be obtained as to rainfall, stream gagings and visible high water marks, etc., proper consideration being given to the particular characteristics of the stream valley and watershed in question. This article deals only with the capacity of the reservoir.

Preparation of Mass Diagrams—Table I is a typical tabulation of the monthly discharge of a stream, supposed to be compiled from actual records taken throughout the period shown—June 1, 1908, to June 1, 1913. For instance, the total discharge for the whole month of December, 1908, was 1.67 billion cu.ft. and the total discharge from June 1, 1908, to Jan. 1, 1909, was 9.39 billion cu.ft., etc. These cumulative discharges from the beginning of the period are plotted as a mass curve, *A*, in Fig. 1. A longer period of time should be used if possible but this five-year period will serve to illustrate the principles involved.

The slope of a line joining any two points of the mass curve indicates the average rate of flow between those two dates. This can be read in cubic feet per second (sec.-ft.) by reference to the vector diagram, Fig. 2.

The total flow for the five years shown was 339 billion cu.ft. and if it should be desired to so regulate the stream as to distribute this flow at an absolutely uniform rate the regulated mass curve would be the straight line *B*, Fig. 1, the slope of which gives 2,150 sec.-ft. as the uniform rate of discharge.

At any particular date the vertical intercept between the two mass curves indicates the difference between the total natural and regulated flows from June 1, 1908, to the date in question, and this is also the difference in reservoir content on the two dates—plus if the natural mass curve is above line *B* and minus if below.

Wherever the mass curves *A* and *B* cross each other the reservoir content is the same as on June 1, 1908.

The maximum intercepts for the period shown are +10.77 billion cu.ft. and −31.40 billion cu.ft. at points *K* and *L* on June 1, 1909, and Feb. 1, 1909, respectively. Hence these points represent the highest and lowest stages of the reservoir for that period; and on June 1, 1909, the content of the reservoir was greater than on Feb. 1, 1909, by 10.77 + 31.40 = 42.17 billion cu.ft.

This is the maximum storage called for by regulation in accordance with line *B* and if the reservoir is assumed as completely empty at its lowest stage on Feb. 1, 1909, it would contain just 42.17 billion cu.ft. on June 1, 1909.

The capacity curve *H*, Fig. 3, gives 774.7 as the elevation of the water surface for this capacity, hence 774.7 is the lowest possible level for the "high flow line" for regulation in accordance with line *B*.

Suppose we assume a "high flow line" at El. 780. The area curve, *I*, Fig. 3, gives the corresponding area of land to be acquired for the reservoir as 29,000 acres. The elevation of the "high flow line" determines the height of the dam.

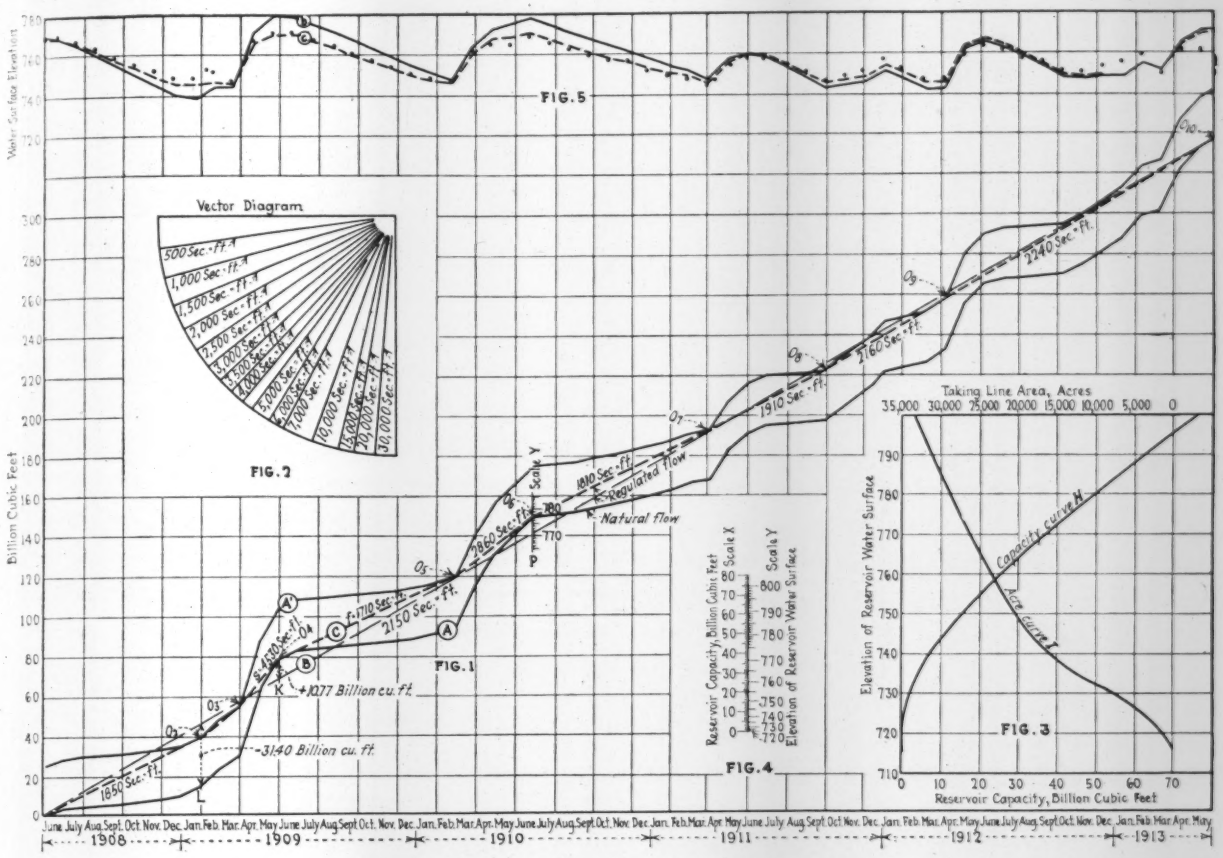
Use of the Scales—The parallel scales, *X* and *Y*, Fig. 4, are graduated to give the same data as the capacity curve, *H*, arranged in form for rapid application to the mass curves for the purpose of studying water surface fluctuations and the effect of different assumptions as to high and low stages of the reservoir and alternative methods of operation.

Scale *X*, representing billion cu.ft., is graduated to a uniform scale equal to the vertical scale of the mass curves. Scale *Y*, representing water surface elevations, is then graduated so that simultaneous values of reservoir capacity and water surface elevation are opposite each other on scales *X* and *Y* respectively.

Scale *Y* can now be separated from scale *X* and applied to the mass curves so as to give water surface elevations direct.

TABLE I—TYPICAL MONTHLY DISCHARGE OF A STREAM

Month	Natural Flow — Billion Cu.Ft. Monthly Flow	Natural Flow — Billion Cu.Ft. Cumulative Flow	Month	Natural Flow — Billion Cu.Ft. Monthly Flow	Natural Flow — Billion Cu.Ft. Cumulative Flow
1908			1911		
June	3.42	3.42	January	2.71	161.83
July	1.00	4.42	February	1.93	163.76
August	0.61	5.03	March	3.29	167.05
September	0.36	5.39	April	15.56	182.61
October	0.96	6.35	May	7.70	190.31
November	1.37	7.72	June	3.86	194.17
December	1.67	9.39	July	0.78	194.95
1909			August	0.53	195.48
January	4.41	13.80	September	1.73	197.21
February	10.04	23.84	October	7.04	204.25
March	5.91	29.75	November	7.04	211.29
April	32.32	62.07	December	9.75	221.04
May	16.50	78.57	1912		
June	4.36	82.93	January	2.81	223.85
July	0.99	83.92	February	1.72	225.57
August	0.92	84.84	March	5.60	231.17
September	0.57	85.41	April	23.94	255.11
October	0.80	86.21	May	9.75	264.86
November	1.02	87.23	June	2.56	267.42
December	1.20	88.43	July	0.56	267.98
1910			August	0.50	268.48
January	2.94	91.37	September	1.50	269.98
February	2.68	94.05	October	4.13	274.11
March	20.26	114.31	November	7.10	281.21
April	15.95	130.26	December	6.20	287.41
May	9.30	139.56	1913		
June	9.56	149.12	January	11.20	298.61
July	0.94	150.06	February	2.97	301.58
August	1.22	151.28	March	20.42	322.00
September	1.61	152.89	April	11.22	333.22
October	1.83	154.72	May	5.78	339.00
November	2.97	157.69			
December	1.43	159.12			



FIGS. 1-5—PRELIMINARY REGULATION CURVES
Fig. 1—Mass curves. Fig. 2—Vector diagram. Fig. 3—Area and capacity curves. Fig. 4—Water surface scale. Fig. 5—Water surface fluctuations.

Under the assumption of El. 780 as the "high flow line," place scale *Y* vertically on the mass curve at point *K*, Fig. 1, so that 780 coincides with the natural mass curve, *A*, and read 771.0 on scale *Y* at its intersection with line *B* as the water surface elevation on June 1, 1908, and on every other date on which lines *A* and *B* cross or touch each other.

Then placing scale *Y* vertically anywhere, so that 771.0 coincides with line *B*, the reservoir water surface on that date is given by scale *Y* where crossed by the natural mass curve, *A*.

Hence, placing scale *Y* at point *L* gives El. 738 as the lowest reservoir level reached during this period.

The water surface fluctuations resulting from the above scheme of operation are shown by curve *b*, Fig. 5, which is quickly plotted by placing scale *Y* vertically on the mass curves at the breaks in them so that 771.0 coincides with line *B* and reading from scale *Y* where crossed by line *A*. This procedure is illustrated at point *P*, Fig. 1, where scale *Y* gives 777.5 as the reservoir level on July 1, 1910, which is plotted accordingly on curve *b*.

Suppose that in order to comply with local requirements it is desirable to confine the water surface fluctuations between elevations 745 and 770. Under such conditions the method can be modified by plotting above the natural mass curve, *A*, a second curve, *A'*, Fig. 1, separated from *A* by a constant vertical intercept equal to the distance between elevations 745 and 770 of scale *Y*. For purposes of illustration assume the reservoir to be full at the beginning of the 5-year period. Then whenever the regulated mass curve touches curve *A* the reservoir is full (El. 770) and whenever it touches curve *A'* the reservoir is empty (El. 745). Hence the ideal regulated mass curve will be a series of tangents to the curves *A* and *A'* and must lie wholly between them and, within this limitation, whenever the slopes of regulated flow are flatter than the average slope *B*, they are to be made as steep as possible and whenever they are steeper than *B*, they are to be made as flat as possible. This results in the ideal regulated mass curve, *C*, tangent to curves *A* and *A'* at points O_1, O_2, O_3, etc., to O_{10}, and coinciding with the natural mass curve *A* at each end of the period analyzed.

The flattest of these regulated slopes is *f*, indicating a minimum regulated discharge rate of 1,710 sec.-ft. instead of the 2,150 sec.-ft. allowed by line *B*; and the steepest slope is *s*, indicating a maximum regulated discharge rate of 4,530 sec.-ft.

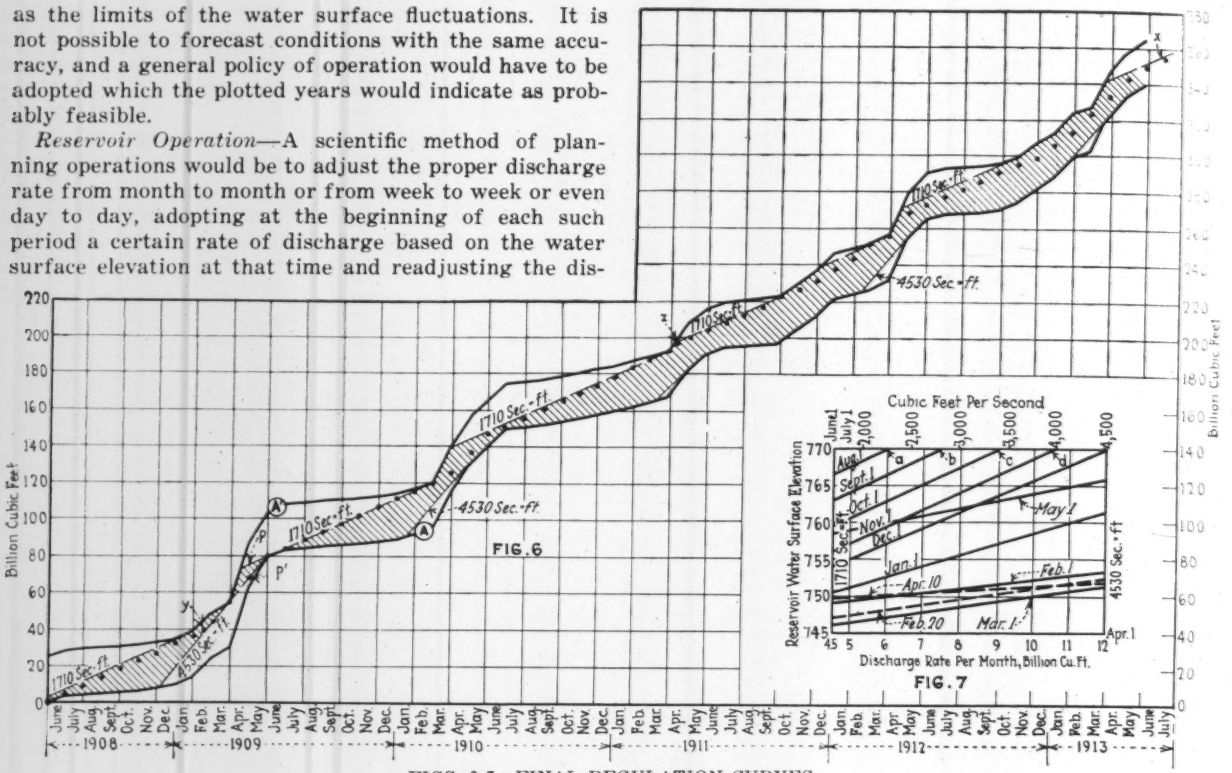
The water surface fluctuations under this scheme of operation are obtained as before by placing scale *Y* vertically on the mass curves so that El. 770 coincides with line *C* and reading the water surface elevation on scale *Y* where crossed by the natural mass curve *A*. These results are plotted as curve *c*, Fig. 5.

With the "high flow line" at El. 770, the area curve *I*, Fig. 3, gives 26,400 acres of land to be acquired.

Line *C* of Fig. 1 indicates what could have been done in the light of the knowledge of the monthly discharges as given by curve *A*, assuming elevations 745 and 770

as the limits of the water surface fluctuations. It is not possible to forecast conditions with the same accuracy, and a general policy of operation would have to be adopted which the plotted years would indicate as probably feasible.

Reservoir Operation—A scientific method of planning operations would be to adjust the proper discharge rate from month to month or from week to week or even day to day, adopting at the beginning of each such period a certain rate of discharge based on the water surface elevation at that time and readjusting the dis-



FIGS. 6-7—FINAL REGULATION CURVES
Fig. 6—Mass curves. Fig. 7—Operation chart.

charge rate at the end of the period as dictated by the water surface elevation then.

This would call for the preparation of an operation chart or table giving the proper discharge rate at any date for any particular elevation of the reservoir water surface on that date. The relation between date, reservoir level and discharge rate would depend upon the results desired and upon the probable stream flow as revealed by long-term records.

Fig. 7 is such an operation chart prepared from the foregoing analysis as plotted in Fig. 1 and Fig. 6. Assuming that the five years plotted in Fig. 1 cover all conditions of natural flow to be expected in the future, also assume from line *C* of Fig. 1 that it is feasible to so operate the reservoir as to keep the discharge rate between 1,710 sec.-ft. minimum and 4,530 sec.-ft. maximum with a water surface fluctuation between elevations 745 and 770. The hatched area of Fig. 6 indicates these limits of the permissible zone of operations, lines *A* and *A'* being identical in Figs. 1 and 6.

The extreme discharge rates are plotted as the vertical ends of the operation chart, Fig. 7, and the upper and lower limits of the reservoir water surface fluctuations are plotted as the top and bottom of the chart. All operation points must be kept within this rectangle. Fig. 7 is graduated horizontally in terms of billion cu.ft. per month for convenience in application, and the horizontal scale at the top of Fig. 7 gives the flow in second-feet.

If a regulated mass curve touches the upper edge of the hatched zone of Fig. 6, the slope of this upper edge to the right of the point of contact gives the *maximum* permissible rate of discharge at that point. If the regulated mass curve touches the lower edge of the hatched zone the slope of the lower edge to the right of the point gives the *minimum* permissible discharge.

Hence if a regulated mass curve touches the upper edge of the hatched zone at a point where the slope of that edge is 1,710 sec.-ft. then that is the only permissible rate on that date and if it touches the lower edge

TABLE II—RESERVOIR WATER SURFACE ELEVATIONS FOR A DISCHARGE RATE OF 1,710 SEC.FT.

	Jan. 1	Feb. 1	March 1	April 1	May 1	June 1	July 1	Aug. 1	Sept. 1	Oct. 1	Nov. 1	Dec. 1
1908	.....	.....	.....	.....	.....	767.5	766.5	763.5	759.5	755.5	751.5	748.5
1909	745.0	.....	.....	.....	758.5	770.0	770.0	766.5	763.0	759.5	756.0	752.0
1910	748.5	747.0	.....	745.5	758.0	762.5	767.0	764.0	761.0	758.5	755.5	754.0
1911	750.5	749.0	746.0	.....	753.5	757.0	756.5	752.5	748.5	.....	.....	.....
1912	749.5	748.0	.....	.....	753.5	759.0	757.0	753.0	749.0	745.5	.....	.....
1913	.....	746.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE III—RESERVOIR WATER SURFACE ELEVATIONS FOR A DISCHARGE RATE OF 4,530 SEC.-FT.

	Jan. 1	Feb. 1	March 1	April 1	May 1	June 1	July 1	Aug. 1	Sept. 1	Oct. 1	Nov. 1	Dec. 1
1908	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	770.0
1909	761.5	753.5	751.5	745.0	766.0	.....	.....	.....	.....	.....	.....	.....
1910	.....	767.0	758.5	766.5	.....	.....	.....	.....	.....	.....	.....	.....
1911	.....	.....	.....	767.0	.....	.....	.....	.....	.....	.....	.....	.....
1912	.....	.....	765.0	759.0	.....	.....	.....	.....	.....	.....	.....	.....
1913	.....	770.0	762.0	.....	.....	.....	.....	.....	.....	.....	.....	.....

of the zone at a point where the slope is 4,530 sec.-ft. then that is the only permissible rate. In either case the corresponding water levels are given by the vertical intercepts between the regulated mass curve and the natural mass curve, *A*, as referred to scale *Y*.

These critical operation points are noted in Tables II and III.

For instance, if May 1, 1909, the regulated mass curve were at point *p*, Fig. 6, the only permissible rate would be 1,710 sec.-ft. and the corresponding water level would be El. 758.5 as in Table II, while if the regulated mass curve were at point *p'* the only permissible rate would be 4,530 sec.-ft. and the corresponding water level would be El. 766.0 as in Table III.

In order to accommodate all of these critical operation points select the highest water levels of Table II and the lowest of Table III and plot these elevations, shown in italics in the tables, as extremities of the operation lines of Fig. 7.

It is noted from Table III that the maximum rate of discharge is called for during April, 1909, even with an empty reservoir on April 1. Hence it is concluded that the month of April should at least start with the maximum rate for any water level and the April 1 column of Table II is ignored. Likewise June and July are always started at the minimum rate.

Points *a*, *b*, *c*, and *d* of Fig. 7 are located by interpolation between the minimum and maximum rates. The year 1913 is not tabulated after February in Table II since there are no data available for the correct location of line *x* of Fig. 6, which is drawn in an assumed position.

The extremities of the operation lines of Fig. 7, located as above, are joined by straight lines for the interpolation of intermediate water levels.

The operation chart as constructed in Fig. 7, applied to the five years in question, results in the regulated mass curve indicated by the dots of Fig. 6 in place of the ideal regulated mass curve, *C*, of Fig. 1.

Table IV gives the steps in this procedure, and the dotted line of Fig. 5, plotted from the water level columns of Table IV, indicate the corresponding water surface fluctuations. Starting with a full reservoir on June 1, 1908, Fig. 7 gives the June discharge as 4.5 billion cu.ft. Total discharge to July 1 is 4.5. This point is plotted as the second dot of Fig. 6. Applying scale *Y* gives the water level on July 1 as 769.0. From Fig. 7 the only permissible July 1 discharge is 4.5 billion cu.ft. per month. The total discharge to Aug. 1 is 9.0. This point is plotted on Fig. 6. Applying Scale *Y* gives the water level on Aug. 1 as 766.0. This is lower than the water level called for by Fig. 7 for the minimum discharge rate of 4.5 billion cu.ft. per month on Aug. 1. Hence the August discharge is held to 4.5. Total discharge to Sept. 1 is 13.5. This point is plotted on Fig. 6, etc., etc.

This procedure gives the minimum discharge rate of 4.5 until point *y* of Fig. 6 is reached, where it is found that the Feb. 1 rate had to be readjusted on Feb. 20, 1909, in order to avoid leaving the permissible zone of operations and necessitating a subsequent rate in excess of the established maximum as an alternative to cutting line *A* and filling the reservoir above El. 770.0.

As a matter of fact in actual practice without foreknowledge of flow the operation chart should be consulted oftener than once a month in checking the discharge rate and, if necessary, readjusting it, interpolating lines for that purpose between the monthly lines of Fig. 7 as shown there for Feb. 20 and April 10. These interpolated lines if inserted for the whole year would make it desirable to split Fig. 7 into two separate charts to avoid confusion of lines. One of these charts would cover the period from April 1 to June 1 and the other the remainder of the year.

The natural mass curve, *A*, assumes uniform rates of flow throughout each month. If curve *A* had been plotted by weekly or daily increments there may be minimum flows slightly less than 1,710 sec.-ft. or maximum flows slightly greater than 4,530 sec.-ft., but this would not alter the foregoing methods in the preparation of the operation chart.

Returning to the process of plotting the regulated mass curve indicated by the dotted line of Fig. 6, Table IV gives a water level of 752.5 on Feb. 20, 1909. This is slightly higher than the water level called for by

TABLE IV—DATA FOR PLOTTING REGULATED MASS CURVE

Date	Discharge, Billion Cu.Ft. Per Month	Discharge, Billion Cu.Ft. Cumulative	Water Surface Elev.
1908			
Jan. 1	....	.....	.....
Feb. 1	....	.....	.....
Mar. 1	....	.....	.....
Apr. 1	....	.....	.....
May 1	....	.....	.....
June 1	4.5	0	770.0
July 1	4.5	4.5	769.0
Aug. 1	4.5	9.0	766.0
Sept. 1	4.5	13.5	762.5
Oct. 1	4.5	18.0	758.5
Nov. 1	4.5	22.5	755.0
Dec. 1	4.5	27.0	751.5
1909			
Jan. 1	4.5	31.5	748.0
Feb. 1	4.5	36.0	748.0
Feb. 20	11.9	39.0	752.5
Mar. 1	11.9	43.0	751.5
Apr. 1	11.9	54.9	745.0
May 1	11.9	66.8	776.0
June 1	4.5	78.7	770.0
July 1	4.5	83.2	770.0
Aug. 1	4.5	87.7	766.5
Sept. 1	4.5	92.2	763.0
Oct. 1	4.5	96.7	759.5
Nov. 1	4.5	101.2	756.0
Dec. 1	4.5	105.7	752.0
Dec. 31	....	110.2	748.5
1910			
Jan. 1	4.5	110.2	748.5
Feb. 1	4.5	114.7	747.0
Mar. 1	4.5	119.2	745.0
Apr. 1	11.9	123.7	762.0
May 1	10.9	135.6	765.0
June 1	4.5	146.5	764.0
July 1	4.5	151.0	768.0
Aug. 1	4.5	155.5	765.0
Sept. 1	4.5	160.0	762.0
Oct. 1	4.5	164.5	759.5
Nov. 1	4.7	169.0	756.5
Dec. 1	5.0	173.7	755.0
1911			
Jan. 1	4.5	178.7	751.0
Feb. 1	....	183.2	749.0
Mar. 1	4.5	187.7	746.0
Apr. 1	11.9	192.2	745.0
Apr. 10	4.5	196.2	747.0
May 1	4.5	199.2	754.5
June 1	4.5	203.7	758.0
July 1	4.5	208.2	757.0
Aug. 1	4.5	212.7	753.0
Sept. 1	4.5	217.2	749.0
Oct. 1	4.5	221.7	745.5
Nov. 1	4.5	226.2	748.5
Dec. 1	4.5	230.7	751.0
Dec. 31	....	235.2	756.5
1912			
Jan. 1	8.5	235.2	756.5
Feb. 1	7.0	243.7	750.5
Mar. 1	4.5	250.7	745.0
Apr. 1	11.9	255.2	746.0
May 1	5.0	267.1	759.0
June 1	4.5	272.1	763.5
July 1	4.5	276.6	762.0
Aug. 1	4.5	281.1	757.5
Sept. 1	4.5	285.6	753.5
Oct. 1	4.5	290.1	750.5
Nov. 1	4.5	294.6	750.0
Dec. 1	4.5	299.1	753.0
1913			
Jan. 1	7.5	303.6	755.0
Feb. 1	11.9	311.1	758.5
Mar. 1	8.5	323.0	749.0
Apr. 1	11.9	331.5	761.5
May 1	6.5	343.4	760.5
June 1	4.5	349.9	760.0
July 1	....	354.4	.....
Aug. 1	....	.....	.....
Sept. 1	....	.....	.....
Oct. 1	....	.....	.....
Nov. 1	....	.....	.....
Dec. 1	....	.....	.....
Dec. 31	....	.....	.....

NOTE—Discharge rate at any date is dictated by water surface elevation at that time. In this table the rates are assumed as constant from the date on which they are established to the next successive date. For instance, from April 1, 1911, to April 10, 1911, the discharge was at the rate of 11.9 billion cu.ft. per month.

Fig. 7 for the maximum discharge rate of 11.9 billion cu.ft. per month on Feb. 20. Hence it is necessary to discharge during the remainder of February at that rate.

The above procedure continued gives either the minimum or maximum discharge until May 1, 1910. On that date the water surface elevation is 765.0, for which the May 1 line of Fig. 7 gives the corresponding discharge rate as 10.9 billion cu.ft. per month, and so on to the end of the 5-year period.

At point *z*, Fig. 6, on April 10, 1911, it again became necessary in the present example to readjust the discharge rate during a calendar month.

The above method of preparing an operation chart is of course subject to modification depending upon the results desired. It may not be considered necessary to use the maximum elevations of Table II and the minimums of Table III. Also, instead of this extreme it might be possible to average the elevations of each column and take a chance on an occasional violation of the established limits of water levels or discharge rates or both. Even after such a chart is prepared it is quite probable that it would be revised from time to time as the years pass and experience accumulates. The straight lines of Fig. 7 may be changed to curves and the extremities may even be shifted.

The fact remains, however, that Fig. 7 presents an operation chart which, when applied to the five years from which it was derived, satisfies throughout that whole period the following requirements:

(a) Reservoir water surface not to go below El. 745.0;

(b) Reservoir water surface not to go above El. 770.0;

(c) Reservoir discharge rate not to go below 1,710 sec.-ft.;

(d) Reservoir discharge rate not to go above 4,530 sec.-ft.

and if the five years analyzed may be regarded as covering all conditions to be met with in the future, Fig. 7 also is an operation chart which would satisfy requirements (a), (b), (c), and (d) for all time without further foreknowledge of the actual flows.

The possibility of such a forecast was first suggested by E. H. Sargent, chief engineer of the Hudson River Regulating Board, and a chart similar to Fig. 7 in principle, originated by Mr. Sargent, has been used on some of his regulation studies very satisfactorily.

Chamber of Commerce Discusses American Business

Secretary Hoover Surveys Business Development for Past 25 Years at Annual Meeting Which Centered on Self Regulation in Business and Considered Many Engineering Problems

SELF REGULATION in business, the economic antitoxin for governmental interference, was the general theme of the fourteenth annual meeting of the Chamber of Commerce of the United States held in Washington, May 10-13. A registered attendance of 3,000 men from different parts of the country all of them leaders in their respective communities and industries, listened to the economic viewpoints of such prominent figures as Herbert Hoover; Paul W. Litchfield, president, Goodyear Tire & Rubber Co.; Julius Barnes, former president of the Chamber of Commerce; and Gov. Albert C. Ritchie of Maryland. In addition, a dozen group meetings were addressed by specialists on important problems confronting American business.

Aside from the fact that the engineering profession as a group is vitally concerned with any meeting touching and affecting our business prosperity as this one did, there were, as usual, many subjects discussed that were fundamentally every-day problems of the civil engineer.

General Topics Discussed—The general sessions were devoted to the broader factors that condition our business situation. The speech of Governor Ritchie on "More Business in Government and Less Government in Business" and that of Mr. Barnes on "Self Regulation in Business" touched directly on the general theme of the meeting. Secretary Hoover gave a remarkable broad survey of those developments in American business in the last twenty-five years that have brought us to our present level of prosperity. John W. O'Leary, president, Chamber of Commerce of the United States, in his annual address at the opening meeting, said in part: "I believe the trade association still is in its infancy and will grow to be one of the greatest factors in the self regulation of business."

Maximum stability and the ultimate security of business were cited by Mr. Barnes and Governor Ritchie as attainable only through self government in business and lack of governmental interference, except in so far as to provide opportunity for all on equal terms. Governor Ritchie believes "that that government governs best which governs least provided it governs wisely." "It is not generally recognized," he said, "how much government actually is in business, not as a regulating or controlling force but in competition with private enterprise. Some of this is doubtless inevitable, but it would be easy to show the resulting economic waste compared with private industry due to a variety of causes but perhaps chiefly due to lack of necessity of showing a profit and to the lack of a permanent policy."

The Traffic Problem, City Planning and Other Group Problems

Group meeting subjects included domestic distribution; foreign commerce; insurance; transportation and communication; natural resources production, in which there were papers on self-government in the hydroelectric, lumber and coal industries; agriculture; civic development; finance; manufacture; state and local taxation and budgeting.

The discussions on transportation and civic development had an intimate interest to engineers. In setting forth the main points recently advanced as a result of the investigations of the National Conference on Street and Highway Safety, Elliot H. Goodwin, resident vice-president, Chamber of Commerce of the United States, spoke of the leading part commercial organizations can take in organizing their communities for highway safety and traffic planning. "To deal promptly and properly with the traffic problem is a fundamental

function of state and local governments," he said. "The genius of commercial organizations and trade associations is by suggestion to guide, stimulate and support the action of the constituted authorities. In most cases at present, the activity of the organization in this connection is a side line to the work of the always overburdened secretary. Where this is the case I would suggest as a first step the appointment of a small committee of business men and transportation executives to survey the problem in the light of the program of the Conference on Street and Highway Safety."

"Co-ordination of Transportation as an Aid in the Solution of the Traffic Problem" was discussed by Frank R. Coates, president, American Electric Railway Association. "You are going to have street cars," said Mr. Coates, "for many years to come; you are going to have more buses; you are going to have more private automobiles. I am urging our electric railway people to regard themselves as transportation experts rather than as strictly electric railway experts. They should have no prejudice for the electric car if the bus would serve the community better; they should not recommend bus service if they know that an electric railway extension would render better service."

Terminal congestion and grade crossings were discussed by R. H. Aishton, president, American Railway Association, as a factor of the traffic problem. Terminal improvement and the elimination of grade crossings are initially financial and finally engineering problems upon which the railroads are ready to co-operate with federal and state regulating bodies, asserted Mr. Aishton.

Three causes for the growth of cities were stressed by George B. Ford, vice-president, Technical Advisory Corp., New York, in his talk before the civic development group. These three causes were industrial activity; connection with sport and recreation; and the attractiveness as a place of residence. In elaboration on the last cause Mr. Ford said, "You cannot have a planned city, with its future capital commitments all budgeted, until you first have a zoned city. You cannot have really effective municipal government until the budgeting program has been adopted. Good municipal government is essential to make or keep a city a good place to live in, and it will not grow unless it remains a good place to live in. There is the whole thing in three sentences."

One of the high spots of the group meetings and in fact of the annual meeting as a whole was the talk by Paul W. Litchfield, president Goodyear Tire & Rubber Co., on "The Present Attitude of Employer and Employee." Mr. Litchfield would cut wages only as a last resort in case of slack times and business depressions. An abstract of his paper follows:

"It used to be the thought that the first thing to cut when profits began to shrink was wages. It is now recognized that this condition should be met by increased efficiency, elimination of waste, the cutting down of overheads in production and distribution, and an attempt to maintain wages by these means, because a general cutting down of wages curtails the demand for the finished products of industry, the demand for which is the very life-blood of prosperity.

"For years it has been the opinion of many that a man should be paid for the time he puts in rather than upon the amount of goods he produces. Management and labor have sharply disagreed on this point.

"While the above principles now are recognized by the great leaders of labor, as shown by the action of the American Federation of Labor, they unfortunately are not shared by all laboring men, and there are still a large number who believe in the principle of reward based upon the time put in. It is the application and the results of this false doctrine with which management has to contend, and it often prevents the full co-operation between management and employees because these principles cannot be reconciled. It is often the influence of men of this type in the councils of labor which makes it difficult for more enlightened labor leaders to hold their men in line.

"Although the standard of living in America is the highest in the world, individual happiness depends after all on the relative position which one has in comparison with his neighbors. Progress, therefore, toward happiness is based more largely on the distribution of wealth than upon the actual total wealth of a nation, and the justification of mass production in the future must rest not alone on the increased wealth produced, but fully as much on the fairness and justice with which this increased wealth is distributed."

Secretary Hoover's Address

Secretary Hoover's paper sets forth the general factors that condition our business situation so ably that an abstract of it follows:

"A century of science has given us powerful tools of production and distribution. In organizing and applying them we have developed at times great friction with the social and political instincts of our people. But I believe that the friction is becoming steadily less. We are making progress in our own way in the fundamental relations of industry and commerce to its employees, to the public, and to the government.

"There is a marked change during the last 25 years in the attitude of employers and employees toward wages and conditions of labor." Here Secretary Hoover referred briefly to the plan set forth by Mr. Litchfield in one of the group meetings and the recently expressed viewpoints of the American Federation of Labor.

"Another marked tendency of the last 25 years is the notable growth of a higher sense of co-operation in the whole community. The majority of the trade and similar associations today have a recognition of their public responsibilities as well as the protection of their own interest. The whole process of eliminating waste through standardizing of dimensions and qualities of goods and business practice is only possible by such co-operation. There are still many wastes induced by destructive competition which need the searching activities of our associations. Nor are these wastes to be conquered by legislative regulations—you cannot catch an economic force with a policeman. But we can make progress by co-operation, and with every lift in the level of competition, self-government in business becomes stronger and competition no less preserved.

"The last twenty-five years have seen the growth of larger and larger units of production and distribution—big business. And there is much confusion about it all in the public mind. I believe the public generally realizes that we get better conditions of labor, lower production costs, and better products sold on narrower margins of profit out of mass production, both in manufactured goods and in transportation power and other

services. Yet the public has the natural fear that these great units will be used for domination and extinction of equality of opportunity. The essential question after all with regard to a unit is whether it is subjected to effective competition, not the size of it. What we sorely need is thoughtful consideration directed to the essential question of how to maintain real competition instead of legalistic formula.

"The concept of business organization of half a century ago was that management was controlled by the owners. But now in certain very important groups the ownership has much diminished in its domination over policies of management by mutualization, diffusion of stock, and governmental limitation of profits. With the lessened pressure to enlarge profits, the tendency is to compromise the possible earnings between wages and prices or rates to the consumer. This has in many cases brought the surprising result of decreased prices in the face of increased demand, and of maintained high wages in the face of surplus of labor.

"Another strong advance in the past quarter of a century has been the increasing stability of credit. This has been effected by the creation of the Federal Reserve System, the growth of investment capital centers in the West, and the financing of working capital from a company's own resources, instead of by borrowing from the banks.

"During this quarter century we have multiplied our students in institutions of higher learning by 400 per cent. Also, we are reaping the benefits of some 600 industrial research laboratories—many recently established.

"Some of our industries have lagged behind others in the march toward stability, although they have kept up the march of efficiency. The bituminous coal industry, textile industry, and especially some important branches of the agricultural industry are not yet in that stable condition which the nation requires. Agriculture remains our most difficult economic problem and is not to be dismissed with a gesture of impatience at ideas which spring from misery, but must be constructively assisted.

"It is true that these economic things are not the objective of life itself. If by their steady improvement we shall yet further reduce poverty and create secure and happy homes, we shall have served under God to make better men and women."

Contracts Approved Over Day Labor

Among the resolutions adopted by the Chamber that are most important to the engineering profession was that on public construction. It reads in part, "We believe that it is in the public interest for all governmental authorities to follow wherever possible the policy of letting contracts for public construction projects rather than to undertake construction by hiring day labor. Construction work is in general better done, performed in less time, and completed at a lower cost by the contract method than by the day-labor method. In cases in which a governmental agency elects to reject bids and performs the work itself, it should be required by law to place upon the public records at the completion of the work a sworn statement showing the actual cost, including all proper overhead charges, and all changes in the original plans."

The Chamber also adopted a resolution favoring all sound proposals for international conferences on the subject of improved highways.

Among the other resolutions adopted were an expression of opposition to the principle of sectional representation on the Interstate Commerce Commission; the pledging of support to local chambers for improving budget-procedure on the part of state and local governments; a hope that the recent changes in the procedure of the Federal Trade Commission will be permanent; a recommendation for a uniform system for recording vital statistics; and an expression of interest in the creation of national parks, which is a primary responsibility of the states and municipalities themselves.

Recent Asphalt Road Construction Plant and Methods

By Prevost Hubbard

Chemical Engineer, The Asphalt Association, New York

Extract from a paper at the convention of the Association of Highway Officials of the North Atlantic States, at Syracuse, N. Y., Feb. 17-19, 1926.

UNDOUBTEDLY the most important single construction detail is initial compression and the use of a heavy roller for first compression of the hot paving mixture cannot be too strongly urged. It has been customary to roll at least fine-aggregate asphalt mixtures with a relatively light tandem roller, prior to using a heavy roller, but this is now known to be far less satisfactory than to use the heavy roller first. A light roller will compact the upper portion of the paving mixture satisfactorily but fails to compress the lower strata thereby forming a crust which serves to distribute the load of the heavier roller later used, to such an extent that compaction throughout the depth of mixture is not secured. Even when the heavy roller is used, best results can only be obtained by continuous rolling at a rate not to exceed 200 sq.yd. per hour per roller.

Use of the tandem roller is advisable for diagonal and cross rolling where initial compression has been obtained with a three-wheel roller. Considerable care is required, however on sheet asphalt or fine aggregate mixtures to use the three-wheel roller to best advantage. It should be backed on to the hot mix and operated very slowly, care being taken not to reverse too suddenly. The large narrow wheels cut into the mixture to some extent but compress it from the bottom up so that reasonably uniform density is secured throughout the entire depth.

Uniformity of contour in the newly constructed pavement is the second important construction detail to observe. This is of course dependent to a large extent upon the care with which the paving mixture is rolled but even with the best of rolling it cannot be secured unless the material has been properly spread and raked by experienced rakers. The mixture should be combed out throughout its entire depth and a wide-spaced deep pronged rake somewhat resembling a potato fork has been successfully used by some progressive contractors and is to be recommended. Where it is necessary that workmen stand at times upon the newly raked material, sandals to the bottom of which are fastened pegs of suitable depth, should be worn. In endeavoring to improve the contour of their pavements a number of contractors have found that the use of lutes about 5 ft. in width is of material assistance. An improved method of placing the mixture has also been adopted with good results. This method consists in spreading the mixture so as to produce a working edge in the form of an inverted V with the apex at the center of the road. The rakers can then stand within the V and rake the mixture diagonally toward the center thus entirely eliminating the tendency to produce raking corrugations at right angles to the center line. When the V-shaped method of spreading is adopted it will be found advantageous to roll the pavement along lines paralleling the sides of the V after the roller has rolled a single longitudinal strip along each side of the road. Such rolling also tends to prevent the formation of construction corrugations.

Mechanical spreaders have been used successfully in the construction of certain types of hot mix asphalt pavements and it is probable that they will be more extensively used in all types in the future.

Application of Vertical Curves to Highway Design

How Designing, Checking and Drafting Curve May Be Somewhat Simplified by Semi-Mechanical Method

By M. W. Furr

Associate Professor of Civil Engineering, Kansas State Agricultural College, Manhattan, Kan.

ONE phase of the problem of economical highway grade design is the proper selection of a vertical parabolic curve to join the proposed grades. Critical conditions occur frequently at hill tops and a satisfactory grade design for the various situations, especially on straight-a-ways, involves the use of a curve of accepted mathematical qualities which will insure adequate clear-vision for the drivers of approaching motor vehicles.

With the grade elevations calculated in the usual manner, assume the governing conditions of the problem to be as follows: For trunk highway, a line 500 ft. long with extremities 5 ft. above the ground must clear the high point of the intervening curved surface; for less important highways where traffic is light, where grading is difficult, or where funds are scarce, a line 350 ft. long with extremities 5 ft. above the ground must clear the intervening high point of the grade as before. In either case, the problem is to select a vertical parabolic curve of equation,

$$X^2 = -4Py$$

to join given tangent gradients, R and F. The rising (plus) grade R, the falling (minus) grade F, and the station length of the required theoretical curve are the variables.

The theoretical length of the required parabolic curve L to satisfy the conditions stated above is determined by equations (1) and (2):

$$\frac{L^2}{4} = -\frac{4P(R-F)L}{8}$$

Let $(R-F) = K$

Then $L = -2PK$

also $6.25 = -20P$

and $P = -0.3125$

whence $L = 0.625K$ (1)

Similarly, for 350-ft. vision

$$L = 0.30625K \quad (2)$$

Curves 1 and 2 of the accompanying diagram, Fig. 1, show minimum station lengths for the various algebraic differences of the given gradients $K = (R - F)$. As a matter of convenience, and for factor of safety, the length of the curve so obtained will be increased to the nearest higher full or +50 station.

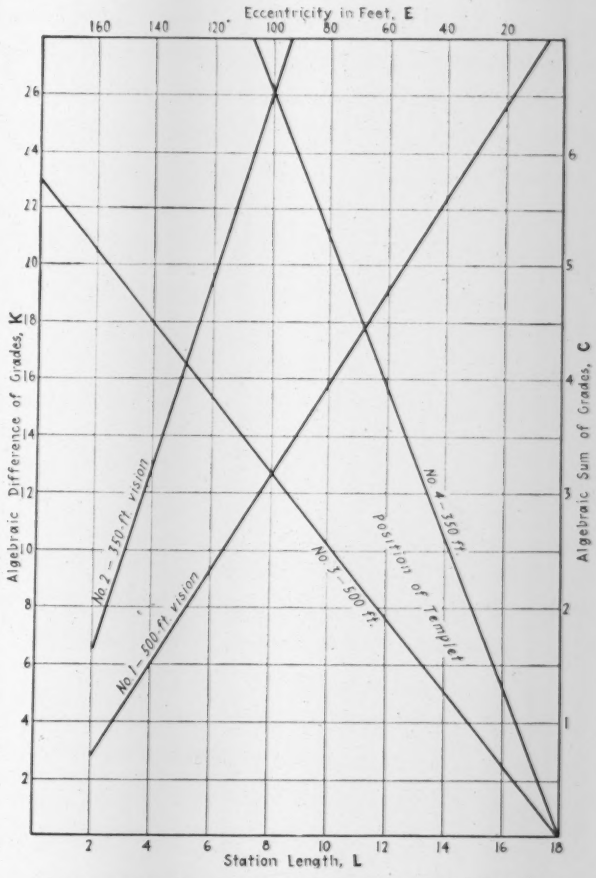


FIG. 1—MINIMUM STATION LENGTHS FOR VARIOUS ALGEBRAIC DIFFERENCES

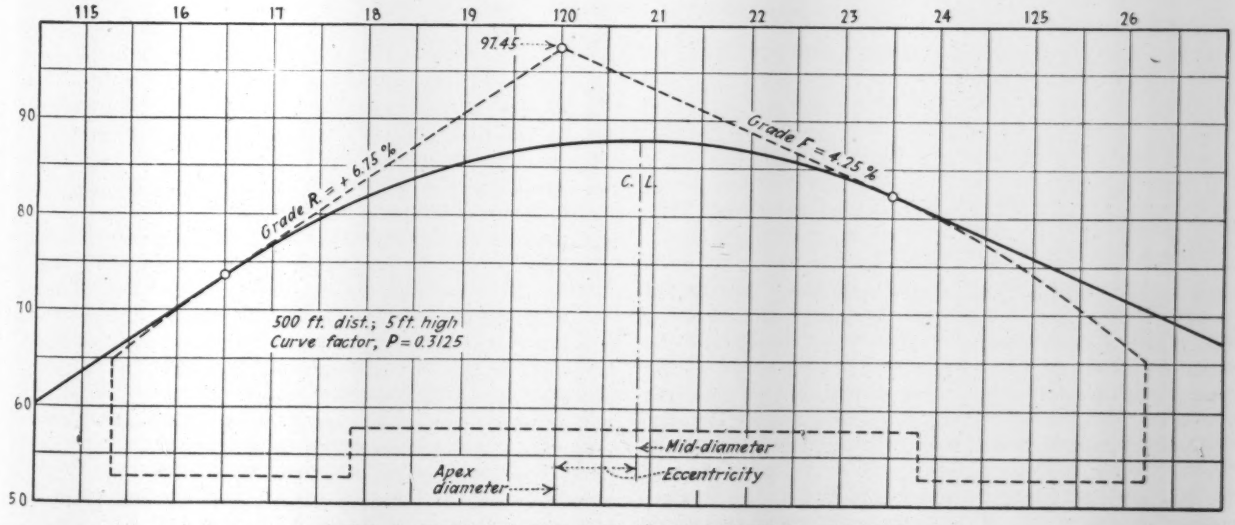


FIG. 2—TEMPLET FOR DESIGNING VERTICAL CURVES

This length is designated as the practicable length, L_p. The accompanying table shows the numerical results for values of K and C for the respective clear-vision distances used, where C is the algebraic sum of the gradients. Obviously, the curve of length L_p is mathematically different from the theoretic curve for lengths of 500 ft. or more. The values of P_a for the altered curve are calculated by equation (3).

$$P_a L = P L_p \qquad (3)$$

The eccentric distance E or abscissa distance in feet from the mid-diameter to the principal ordinate axis of the curve, for a definite value of C, may be found by equation (4) as follows:

NUMERICAL VALUES DETERMINED FROM VERTICAL CURVE FORMULAS

(Lp = L increased to nearest multiple of 50)

Alg Grades		500-Ft. Vision, P = 0.3125					350-Ft. Vision, P = 0.153125				
Diff. K	Sum C	Length, Ft. $100L$	Lp/L Q	Curve Factor Pa	Eccentricity E	Eccentricity Ep	Length, Ft. $100L$	Lp/L Q	Curve Factor Pa	Eccentricity E	Eccentricity Ep
3.20	0.00	200	1.000	0.3125	0.0	0	.....	.....	.....	.....	.....
4.00	0.40	250	1.000	0.3125	12.5	12	.....	.....	.....	.....	.....
4.80	0.70	300	1.000	0.3125	21.9	22	.....	.....	.....	.....	.....
5.60	1.00	350	1.000	0.3125	31.2	31	200	1.000	0.15312	15.3	15
8.00	2.00	500	1.000	0.3125	62.5	62	250	1.000	0.15312	30.6	31
9.00	2.50	562.5	1.066	0.333	78.1	83	300	1.000	0.15312	38.3	38
10.00	3.00	625.0	1.040	0.3250	93.7	97	350	1.000	0.15312	45.9	46
11.00	3.50	687.5	1.018	0.3182	109.4	111	350	1.000	0.15312	53.6	54
12.00	4.00	750.0	1.000	0.3125	125.0	147	367.5	1.088	0.16667	61.2	67
13.00	4.50	812.5	1.046	0.3269	140.6	...	398.1	1.005	0.15385	68.9	69
14.00	5.00	875.0	1.028	0.3214	156.2	160	428.7	1.050	0.16071	76.6	80
16.00	6.00	1,000.0	1.000	0.3125	187.5	187	490.0	1.020	0.15625	91.9	94

Equation of grade tangents

$$y = RX + R^2P$$
$$y = FX + F^2P$$

Solving when $X = E$

$$E = -P(R + F) \qquad (4)$$

and

$$E_p L = E L_p \qquad (5)$$

The respective results for 500- or 350-ft. clear-vision are given in the table and by curves 3 and 4 of Fig. 1. When F is less than R the high point (origin) of the curve will be to the right of the mid-diameter, that is, E is minus.

A templet of transparent material, constructed on the scale of the profile, as shown by Fig. 2, can be used in designing, inking or plan-checking of all peak vertical curves to conform with the hypothesis. The principal y-axis line, a horizontal line and the templet index should be etched on each instrument for the purpose of drawing-board orientation and identification. The templet is to be centered at the proper eccentric distance to the right or left of the mid-diameter, and with the length of the curve predetermined, the grade line is drawn. The slight discrepancy introduced by the use of the same templet for the drafting of the various practicable length curves will be insignificant. It is interesting to note that the eccentric distances for the 350-ft. condition are approximately one-half of those for the 500-ft. clear-sight distance.

Example: With R of +6.75 per cent and F of −4.25 per cent. $K = 11$. For vision of 500 ft., $L =$ 6.87 stations from diagram. $L_p = 7.0$. Eccentric distance for $C = 2.50$ is 78 ft. $E_p = 1.02 \times 78 = 80$. Center the templet as indicated in Fig. 2, and draw the curve of 700 ft. symetrical about the apex diameter. With the break of grade, station 20, at the elevation of 97.45; the elevations of stations 18 + 30, 20 + 80 and 23 + 30 are 83.44, 88.33 and 83.40, respectively. Consequently, a line 500 ft. in length will clear the grade at a height of 4.91 ft.

Engineer Proposes Elevated Causeways for St. Louis Traffic Relief

RELIEVING traffic congestion and providing rapid transit in St. Louis and to its suburbs has been the subject of an investigation made by Edward J. Beard, an engineer of that city. He comes to the conclusion that building causeways covering all of each lot fronting on one side of the streets providing the best rapid transit routes would be cheaper and better than utilizing those streets for traffic, either on, above or under the surface. On these causeways he would run the present trolley cars. He concludes that the rapid transit facilities should be purchased by the city and leased to an operating company, whose rental payments would pay a large part of the cost of the causeway construction. There would be room on the causeway structure for wide boulevards for express automobile traffic. Of such causeways 25 miles would be necessary.

In the downtown section, street car stations would be spaced about two blocks apart, but after passing out of the downtown section, no stops would be made on the causeway structure, the cars passing on to their assigned section of surface tracks.

The location of the route proposed in St. Louis is through a section in which the improvements are very poor and with few exceptions could be wrecked. The property to be acquired for the system would cost about one-half the total cost of the project.

Through the residence sections of the city the causeway would be an elevated structure consisting of a fill between concrete retaining walls. The paved surface of the fill would carry the trolley tracks with boulevard space on each side. Reaching the business district, the structure would have two levels. The boulevards would run on the roof and the trolley tracks would run below in a closed-in trackway. Also the boulevard would be wide enough to provide for considerable parking. The space beneath the boulevard, not occupied by the enclosed trackway, would be devoted to garages. The causeway structure would be passed through office buildings wherever necessary.

Mr. Beard estimates that the program of widening 100 miles of streets upon which St. Louis is now proceeding will require condemnation proceedings for four times the amount of the property required for 25 miles of causeways and that the cost per foot of causeway and subway would be the same but that the income from three floor areas beneath the causeway structure would make the final cost of causeway two-thirds that of the subway. He carries his estimate still further to show that to widen a street about 40 ft. will cost about three times as much as a comparable length of causeway.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

European River-Hydraulics Laboratories

REVIEWED BY ERNEST W. SCHODER

Professor of Experimental Hydraulics, Cornell University, Ithaca, N. Y.

DIE WASSERBAULABORATORIEN EUROPAS; ENTWICKLUNG AUFGABEN ZIELE—Unter mitarbeit von (among others) Conrad Matschoss, H. Engel, R. Winkel, Th. Rehbock, J. R. Freeman; Im Auftrage Des Vereines Deutscher Ingenieure; Herausgegeben von G. De Thierry und C. Matschoss. Berlin: G. M. B. H. Cloth; 8x12 in.; pp. 431; 512 halftones and line cuts, 6 colored plates, 3 other plates. 50 reich marks in Germany.

For the designing and consulting engineer, especially if he has to do with river and harbor construction, the great value of this unique volume on laboratories for study of river hydraulics doubtless consists in its presentation of a vast array of problems that arose in recent practice, and in whose solutions the indications (properly interpreted) of experiments on small models played a leading part. Fully half of the book is devoted to such experimental studies and their relations to practice. The nature of the problems involves almost the whole field of hydraulic engineering. Here is a condensed record of numerous striking similarities observed between the action of water on small models and on the large engineering constructions which were, to a greater or less extent, based on the laboratory studies, or vice versa. Indeed, on the hereby involved question of the trustworthiness of experiments on small models, the reader will find that the decision has not been allowed to rest merely on practical successes (naturally deemed by conservative engineers as subject to some degree of personal bias), but that the effects, if any, of change in scale have themselves been made the subject of precise scientific study in the laboratory. Professor Rehbock in particular has made a considerable beginning in this matter.

Many of the experimental results are described in compactly arranged summaries. The brevity of these records is relieved by auxiliary descriptions of important features of the model tests and by comments on the applications to the practical problems. The many line cuts, plottings, and striking photographs serve to make clear just what was done and what was discovered. At the ends of chapters there are eleven bibliographies, totalling 135 references to technical literature, mostly German publications.

Of the 18 chapters 14 are monographs describing the equipment and the important investigations of as many laboratories, nine of which belong to the Technical Colleges (Hochschulen) in cities of Germany, Sweden, Austria, and Czechoslovakia. The other five laboratories are the Berlin Experimental Institute of Hydraulic and Naval Construction, the Leningrad (St. Petersburg) Hydrotechnical Laboratory, and the Experimental Institutes for Hydraulic Construction at Wilhelmshaven Navy Yard, in Vienna, and in Dantzig. The Dresden and Karlsruhe Laboratories are nominally devoted particularly to river-training (Flussbau).

The book is made a fairly complete technical unit by the short Chapters II and III. In Chapter II Professor Engels discusses the value of experiments on models, their advantages and disadvantages, the costs of such studies, the money value of the results, and then the general laws of similarity connecting model and original with respect to relative velocities, times, discharges, forces, moments, work, energies, influence of friction, etc. In Chapter III Dr. Winkel discusses the limits of the transferability of experimental results, and takes up the similarity of models with particular reference to river hydraulics involving scouring and sedimentation. Additional comments on these topics occur here and there throughout the book.

In Chapter IV Prof. Möller presents several experiments demonstrating how water develops one kind of spiral flow in a straight-away part of a river and another kind in going around a curve, showing the causes of scouring and shoaling.

In Chapter V Professor Engels gives very brief descriptions, but states clearly the problems and the main (illustrated) results, of twelve experimental studies made at Dresden. The mere list of topics will serve to illustrate their variety and practical aspect: Protection of pier foundations against undermining; imitation in miniature of a 2½-mile stretch of the river Elbe; corresponding effect of low-water guide walls on the deepening of the fairway; improvement of the bed of straight or gently curved river with shifting bottom; flow effects on sandy bottom as influenced by groins; silting of the old Brunshüttel entrance of the Kaiser Wilhelm Canal; ascertainment of the causes of a cave-in beyond an improved bend on the Lausitzer Neisse River; studies to decide whether a harbor entrance on a convex river (Rhine) shore is better placed on the upstream or downstream side of the "point"; cross-section of dune protection walls attacked by breaking waves in storms; studies on spillway or relief weirs in the side-walls of a channel, leading to a simple modified weir formula.

In Chapter VI, Professor Rehbock describes first the work done in the old Karlsruhe River Construction Laboratory, 1901-21, and next the investigations in the greatly enlarged and improved new laboratory, 1921-25. The older studies are summarized in tabular form on the large pages, one page accommodating 15 studies, each having a line cut 1¼ in. wide by ½ in. high in the middle column, and another page giving the data likewise for 10 practical studies. This surely must be classed as an achievement in condensation! However, 20 pp. of additional description with as many halftones and a dozen line cuts properly dilute the material. Even a list of the subjects of this and following records would extend far beyond the scope of a book review. Nevertheless it may be significant to state that the somewhat less condensed summary of work done in the new laboratory gives good information on 13 "scientific practical" studies, 16 studies for practical construction problems, 5 for testing the validity of the law of similarity, 3 on the discharge phenomena appearing upon the closing-off of the Zuider Zee. Again we find illuminating discussion on these series of investiga-

tions covering 22 pp. Rehbock ends with a bibliography of 26 references.

In Chapter VII Doctors Krey and Winkel, under 8 heads, tabulate 41 studies comprising rivers, canals, weir and guard gates, sluices for inland and ocean canals, dams, seashore and harbors, ship construction, etc., all made at the Berlin Institute. Some of these are discussed in 16 pp. containing 50 illustrations.

These comments will perhaps serve to show the scope of the book under review, although an equally interesting and valuable half of the work has been left without discussion. It should be stated, however, that the descriptions of the equipment of the 14 laboratories are excellently given, and, while appealing particularly to a rather limited number of readers, must be classed of equal importance with the records of achievements. The fact that such a laboratory as the new one at Karlsruhe cost only about $100,000 suggests that the investment has already yielded copious earnings.

Of great interest and value are 48 rules for the construction of river-training laboratories, for the conduct of the investigations, for their evaluation and utilization, and for the publication of the results.

The existence of this remarkable book is due (states Conrad Matschoss, Director V.D.I., in the Preface), to the stimulation given to the editors and collaborators by John R. Freeman following his 1924 European visit. He desired to have published a comprehensive book in German and English, giving a record of what had been accomplished to date in hydraulic research—this for the furtherance of hydraulic construction the world over. The reviewer hopes that English speaking countries may soon have the full benefit of the volume in a translation in their own language.

Mr. Freeman was persuaded to contribute the first chapter to the volume. It remains eminently vigorous in the German rendering by Professor de Thierry. Among the eight subdivisions of the chapter one notes No. 5, Problems Solved and Those Awaiting Solution, which contains the list of 65 topics given in Trans. Am. Soc. C.E., Vol. 87 (1924), p. 1044; and No. 8, Some Noteworthy American Hydraulic Laboratories, in which there is a most readable running review of the work of 10 outstanding experimenters from the time of Francis to the present.

The headings of the six parts of de Thierry's final chapter seem worth quoting as a suggestion of his virile outlook: How can the future co-operation of all laboratories for hydraulic construction be developed; Prerequisites for fruitful work by the experimental institutes; Laboratories for college teaching, for research, and for practical experiments; Inferences to be drawn from existing experimental institutes for the benefit of future laboratories; A fleeting reveiw of the research results at hand; Whither leads the extension of our knowledge?

The book has a table of contents occupying seven of its large pages, and at the end there is an alphabetical index with about a thousand entries. The arrangement and typography leave no room for criticism.

Although hydraulic engineers who have followed European practice may be familiar with many of the studies described in this work, it seems probable that a reading of it will serve as a guide to some hitherto unrecognized researches of great value. In view of the successful accomplishments of American turbine builders when they commenced to combine laws of similarity with the good old cut-and-try methods of design, may there not be more than a suggestion for improved methods of attacking more complex hydraulic construction problems in the reverse method of combining studies on the behavior of properly built models with available theory and lessons from experience with practical successes and failures in construction? European engineers are diligently making use of what they have come to regard as an indispensable aid.

All libraries of consequence should have this volume, and no hydraulic engineer who can in any way deal with the German language should avoid a first-hand acquaintance with its contents.

Much Information for Railway Men

RAILWAY ENGINEERING AND MAINTENANCE CYCLOPEDIA: An Authoritative Manual of Engineering, Maintenance and Signaling, Including Definitions, Descriptions, Illustrations and Methods of Use of the Materials, Equipment and Devices Employed in the Construction and Maintenance of Tracks, Bridges, Buildings, Water Service, Signals and other Fixed Railway Properties and Facilities—Editor, Elmer T. Howson, Western Editor of *Railway Age* and Editor of *Railway Engineering and Maintenance*; Managing Editor, W. F. Rench, Formerly Supervisor, Pennsylvania Railroad System; Associate Editors, Neal D. Howard and F. M. Patterson, Assisted by Philip G. Lang (Bridge Section), A. L. Sparks (Building Section), C. R. Knowles (Water Service Section), and B. T. Anderson (Signal Section). Compiled and Edited in Co-operation with the American Railway Engineering Association and the Signal Section, American Railway Association. Second Edition. New York: Simmons-Boardman Publishing Co. Cloth or leather; 9 x 12; pp. 1072; halftones, line cuts, insert plates. Cloth, $8; leather, $10.

The second edition of the Maintenance-of-Way Cyclopedia (see *Engineering News-Record*, May 19, 1921, p. 863, for notice of first edition) has been rewritten entirely and changed in form as well as in name, the new name being Railway Engineering and Maintenance Cyclopedia, to indicate more clearly that the book was prepared under the direction of the editorial staff of *Railway Engineering and Maintenance*. A small staff of railway men assisted in the preparation of the book and the American Railway Engineering Association and the Signal Section of the American Railway Association co-operated in the work. The new book is a large one with over 1,000 8x11 pp., liberally illustrated.

The first part of the book is a dictionary of terms used in railway engineering and maintenance practice, a very valuable collection of definitions including many from the publications of the American Railway Engineering Association, the Signal Section of the A.R.A. and the American Wood Preservers Association.

The remainder of the book is given over to chapters dealing with various subdivisions of the maintenance-of-way field, such as track, bridges, buildings, water service stations, signals, and a general section. Each section is again divided into subsections which give an editorial discussion of the particular subject followed by a detailed description of various types of equipment used in the particular field in question, followed again by a further statement prepared by the manufacturers of the various types of equipment, setting forth the qualities of their equipment. Such an arrangement has some advantages in the way of simplicity, but the change from an unprejudiced description of equipment prepared by the editors to a prejudiced description prepared by the manufacturers without a distinct change in type or page form is bound to be confusing to the reader looking for unprejudiced information, and lays undue stress upon the product of the manufacturer who has provided a more detailed description of his product than that of his competitors and who also has provided

illustrations which are used not only in the sections devoted directly to his equipment, but in the editorial descriptions as well, a procedure which has resulted in duplication of not a few illustrations. Aside from this feature, which is one of make-up, the volume constitutes a remarkable reference book for railway engineers, signalmen and trackmen.

Physics and Mathematics of Vibration

VIBRATION IN ENGINEERING—By Julius Frith, M.Sc., M.Inst. E.E., M. Assoc. Consulting Engrs.; and Frederick Buckingham, B.Sc. (Eng.), Associate of City Guilds Inst., Assoc. M. Inst. Civil Engrs., Assoc. M. Inst. Mechanical Engrs. [Reconstructive Technical Series, General Editor; B. W. de Tunzelman.] London: Macdonald & Evans. Cloth; 6x9 in.; pp. 123; 41 line cuts.

The scanty literature on vibration as it affects machinery and the buildings that shelter machinery is notably increased by this small monograph (published in 1924 but just brought to our attention). Most of the previously published material on this subject is scattered through periodical literature, as is attested by some forty references given at the end of this book. Curiously enough a book published some three years ago entitled The Prevention of Vibration and Noise, by A. B. Eason (see these columns, Dec. 20, 1923, p. 1027, for a short notice) is not mentioned in the book before us, although the earlier like the late volume was published in England. Possibly this is due to the fact that Mr. Eason's book "is essentially," to quote from our notice of it, "a bibliographical summary of what various people have studied and written on this topic."

The present authors deal at length with free, forced, and damped vibrations, and present the mathematical aspects of such motions in some detail. They deal only with simple vibrations, however, and confine themselves to the single practical case of vibrations of machinery shafts. But many engineers who are concerned with quite other vibrating systems may find the book decidedly helpful because of the effective way in which it presents the essential line of mathematical attack on the subject. In addition, a few hints on factors favoring or opposing the transmission of vibrations may be useful to those who have to deal with troubles of the kind.

World Events and Progress in 1925

THE NEW INTERNATIONAL YEAR BOOK: A Compendium of the World's Progress for the Year 1925—Editor, Herbert Treadwell Wade. New York: Dodd, Mead & Co. Cloth; 7 x 10 in.; pp. 772; maps and halftone plates. Cloth, $6.75; red buckram, $7.75.

The international character of this long-established annual (first published to cover the year 1898) may be illustrated by references to some of the engineering articles in the current issue. Thus, besides dealing with American happenings and progress, the article on Flood Protection has a paragraph on a project in Czecho-Slovakia; Rapid Transit has notes on Paris, Santiago (Chile) and Tokyo; Reclamation deals with irrigation work in Mexico, Haiti, Argentina, Peru, Egypt, India and Australia, and with a project on the Salonika Plain, Greece, for which an American concern has a $27,000,000 contract; under Tunnels one learns of the practical completion of the Rove tunnel, a part of a canal project to connect Marseilles with Central France.

The articles mentioned are but a few of those dealing with engineering and allied subjects. Railways, for instance, contains a summary of electrification progress, with information on the extending use of Diesel-electric locomotives. City Planning, Garbage, Roads, Sewerage and Water Supply are some of the other engineering and municipal subjects treated. Besides engineering, the other scientific topics one would expect to find in such a volume are ably covered, and also art, literature, music, finance, commerce, the industrial arts and hundreds of other subjects.

Influences Affecting Concrete

REVIEWED BY P. H. BATES

Chemist, Bureau of Standards, Washington, D. C.

DER BETON: Herstellung, Gefüge und Widersstandsfahigkeit gegen physikalische und chemische Einwirkungen—Von Dr. Richard Grün, Direktor am Forschungsinstitut der Huttenzementidustrie in Düsseldorf. Berlin: Julius Springer. Paper; 6x9 in.; pp. 186; 54 halftones and line cuts; 35 tables.

Doctor Grün has written an interesting book on a subject which is apparently as much to the front in Germany as in the United States. The title does not quite indicate the subject matter, which has to do mostly with "physical and chemical influences" and very little with the "manufacture, structure and ability to resist" those influences. About a third of the volume comprises a digest of the literature dealing with whatever in the making or hardening of concrete may advantageously or adversely affect its serviceability, while a half of the book digests the literature referring to whatever agencies may affect its serviceability after hardening, and suggestions as to how the desired service may be improved comprise the remainder.

In the two first parts of the work the author emphasizes the grading of the aggregate according to Fuller, the use of the proper water—cement ratio (not according to any one) and proper mixing. Some brief attention is given to the effect of the impurities in aggregates and water and the effects of such agencies as front, heat and ground-water on the hardening concrete as evidenced in its history after the hardening has taken place. This portion is covered too briefly to be adequate and does not give the proper place in the picture to the more recent work in this respect.

The third and main portion of the volume is all-inclusive and covers a most astonishing list of materials that may be and apparently have been harmful to concrete. One can find discussed the origin, general properties and the affects on concrete of many acids, bases, organic and inorganic salts, oils, fats, colloids, and a great variety of the commercial liquid commodities which might in their course of manufacture come into contact with concrete. Included among these liquids are certain ones of historical interest (in the United States) only, as beer and wine, and such an important one, at least in Germany, as sauerkraut, although it is surprising to find this classed as a liquid. The array of names of materials that have been the subject of investigation as a result of their attacking concrete is so imposing as to raise the doubt if concrete has any chance to endure even for a brief time, let alone be permanent.

The final portion, given over to remedial measures that may be adopted, indicates that Germany is, like the United States, well supplied with almost countless integral and applied agencies which are suggested as the panacea for producing lasting, unattackable concrete. This part of the volume should be of value to those in the United States who have tried all those panaceas available here without the desired result and are looking for just as apparently well advertised commodities elsewhere. The author not only gives the names of these

but also their general nature, how and where used, by whom made, and in certain cases the result of their usage. Over forty products are cited, some of which are however, readily recognizable as available on our market.

Under the name either of Zement-Kanone or Zement-Injektor or Beton-spritzverfahren or mortelspritzverfahren is recognized a modification of the cement gun.

This little volume may serve to make us realize that notwithstanding how small or great we may consider our own concrete troubles, others in a distant part of the world are having the same troubles and are studying them and attempting to remedy them in the same manner as Americans.

PUBLICATIONS RECEIVED

A SOLUTION OF NEW YORK'S TRANSPORTATION PROBLEM by use of alternate stops and continuous platforms is offered by Philip Sacks in a 64-p. reprint from the *Municipal Engineers Journal*, New York, 1925.

THE CITY OF GRAND RAPIDS, MICH., through its director of public safety, James Sinke, has issued a bulletin entitled "Think," an analysis of automobile accident causes, which could well be read by every municipal official responsible for motor traffic. It analyzes the accidents in Grand Rapids and their causes in great detail and presents some general statistics and some conclusions as to proper administrative practice to reduce traffic trouble.

TRADE STANDARDS, formulated by representatives of various manufacturers in a given line, are increasing in number and are being made generally available in a form useful to engineers and others outside the particular industry more directly concerned. An example of this is afforded by the second edition of a pamphlet entitled Trade Standards, issued by the Compressed Air Society, 90 West St., New York City.

BEACH EROSION and methods of providing for beach accretion and protection are outlined in a small pamphlet by H. V. Campbell, assistant chief engineer, Manila Railroad Co., Manila, P. I. The observations given are the result of the author's experience while a field engineer for the Board of Commerce and Navigation of New Jersey in its study of beach protection along the New Jersey coast.

THE DELAWARE PORT COMMISSION, of which A. C. Middleton is chairman, has made a 40-p. report to the New Jersey Legislature recommending the creation of a South Jersey Port Commission to formulate a policy for the comprehensive development of the Delaware River. The report consists chiefly of an industrial survey of the river from Trenton to Cape May by Smith, Stamford & Sherman, consulting engineers, 19 Hudson St., New York City.

CEMENT-LIME MORTARS, by H. V. Johnson is the report of an extended series of tests made by the United States Bureau of Standards, in which the percentages of cement, lime and sand were varied. In addition to reporting the results of the test, the pamphlet contains recommended practice for the making of mortar, based on the tests. This embodies an attempt, according to the author, to evaluate the properties of a mortar and indicates the specific measures that should be taken for good mortars. (15c. from Superintendent of Documents, Washington, D. C.)

THE TRADE WASTES PROBLEM in relation to water pollution in Holland is taken up in two papers by E. Cauterman and A. Hennekinne, reprinted from *des Annales* de l'Association des Ingénieurs sortis des Ecoles speciales de Gand for 1925. The first deals with the general subject and describes some experimental work and the second describes working installations for the treatment of various kinds of industrial wastes. (For copies, address A. Hennekinne, chef de Travaux, á l'Universite de Gand, 107 Avenue St. Denis, Gand, Belgium.)

ARCHITECTURAL ACOUSTICS, a 9-p. circular of the Bureau of Standards, summarizes the basic principles of this important subject in language a layman can understand. In addition, it presents the simple formula of Sabine for the calculation of reverberation time and gives sound absorption coefficients for many substances and objects (persons, church pews, etc.) together with examples of absorption calculations. The closing topic, Planning an Auditorium, rounds out a notable publication which should be useful to many engineers and all architects. (5c. from Superintendent of Documents, Washington, D. C.)

A FRESH STUDY of an old problem, with particular relation to a large section of the West, has been made by Samuel Fortier, associate chief of the Division of Agricultural Engineering, Bureau of Public Roads, under the title, Irrigation Requirements of the Arable Lands of the Great Basin. After describing the area in question, the character of its soil its climatic conditions, water supply, and agricultural products, the study goes into the duty of water for irrigation, taking also into account the deficit thereon of state, community and corporate regulation. Diagrams and maps are included (10c. from Superintendent of Documents, Washington, D. C.).

TWO PAPERS recently prepared by the Physical Department of the Ministry of Public Works, Egypt, are now on sale by the government's publication office, Dawawin P. O., Cairo, Egypt, priced "P. T." 5 and 10 respectively. The smaller paper is entitled An Experiment to Determine Corrections to Sounding in River Gauging and was written by P. Phillips, director, Hydrological Service. The larger paper has a much wider scope, dealing as it does with The Lake Plateau Basin of the Nile. Its author is H. E. Hurst, controller, Physical Department. The sounding studies showed for deep water that the stay wire used to hold the sounding wire in a vertical position actually increases the curvature and length of the wire due to the drag of the water on the wire. Correction factors have been worked out and are given in the paper.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

CORROSION—CAUSES AND PREVENTION: An Engineering Problem—By Frank N. Speller, D. Sc., Director of Metallurgical Department, National Tube Co. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 621; 125 line cuts and halftones. $6.

THE ENGINEERING INDEX: 1925 New York: The American Society of Mechanical Engineers. Cloth; 6x9 in.; pp. 792; $6 to members, $7 to non-members.

Continues along the usual lines of indexing the engineering and allied periodicals of the world, with summaries of the articles; contains some 15,000 original entries, and 3,000 cross-references.

KREISPLATTEN AUF ELASTISCHER UNTERLAGE: Theorie Zentralsymmetrisch Belasteter Kreisplatten und Kreisringplatten Auf Elastisch Nachgiebiger Unterlage. Mit Anwendungen der Theorie auf die Berechnung von Kreisplattenfundamenten und die Einspannung in Elastische Medien—Von Dr.-Ing. Ferdinand Schleicher, Privatdozent an der Technischen Hochschule Karlsruhe. Berlin: Julius Springer. Cloth; 6x9 in.; pp. 147; 52 line cuts. Paper, 13.5, cloth, 15 marks, gold, in Germany.

METAL SPRAYING: The Origin, Development, and Application of the Metal-Spray Process of Metallization—By T. Henry Turner, M. Sc., Lecturer in Metallurgy, The University of Birmingham (England); and N. F. Budgen, M. Sc., Ph. D. London: Charles Griffin & Co., Ltd.; Philadelphia: J. B. Lippincott Co. Cloth; 6x9 in.; pp. 170; 165 halftones and line cuts; bibliography.

PERSPECTIVE: An Elementary Text Book — By Ben J. Lubschez, Fellow of the Am. Inst. Architects, author of "Over the Drawing Board, a Draftsman's Hand Book." Fourth Edition, Completely Revised. New York: D. Van Nostrand Co. Cloth; 5x7 in.; pp. 129; 38 line cuts, including some insert plates. $2.

VON DER BEWEGUNG DES WASSERS UND DEN DABEI AUFTRETENDEN KRAFTEN: Grundlagen zu einer praktischen Hydrodynamik für Bauingenieure—Nach Arbeiten von Staatsrat Dr.-Ing. e. h. Alexander Koch, s. Zt. Professor an der Technischen Hochschule zu Darmstadt; herausgegeben von Dr.-Ing. e. h. Max Carstanjen; Nebst einer Auswahl von Versuchen Kochs in Sasserbau-Laboratorium der Darmstadter Technischen Hochschule, zusammengestellt unter Mitwirkung von Studienrat Dipl.-Ing. L. Hainz. Berlin: Julius Springer. Cloth; 8x10 in.; pp. 228; 331 halftones and line cuts, 2 plates. Cloth, 28.5 marks, gold, in Germany.

ZAHLENTAFELN ZUR BEMESSUNG DER SCHUBPEWEHRUNG VON EINFACHEN UND DURCHLAUFENDEN EISENBETONBALKEN: Mit einer einführenden Betrachtung über die Entwicklung der Einschlägigen ministeriellen Vorschriften—Von Dr. Ing. Luz David, Mag.-Baurat bei der Baupolizei. Berlin, und Dipl.-Ing. H. Peri, Ingenieur der "Huta," Breslau. Berlin: Guido Hackenbeil. Paper; 5x7 in.; pp. 60; 12 line cuts; 18 tables in all. 4.2 marks in gold, Germany.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

General Contractors Board Meets at Washington

Day-Labor Legislation Now Before Congress—To Direct Thought on Licensing Contractors

(Engineering News-Record Staff Report)

Real progress was made in the interests of construction at the meeting last week in Washington of the executive board and president's council of the Associated General Contractors. Cheered by the election of Arthur S. Bent, Los Angeles, of the association to a directorship in the Chamber of Commerce of the United States and by the news that the sub-committee of the House Committee on Judiciary had reported favorably on the bill to restrict day-labor construction by Federal departments and bureaus doing construction, the half hundred contractors in attendance went vigorously at their task of discussing and acting on the three score routine and special questions listed for consideration. For the most part these questions were quickly disposed of by hearing and affirming the progress reports of the committees, leaving the active problems of day-labor legislation, quantity surveys, lien laws, licensing contractors, and surety bonding to be discussed at length.

Day-Labor Legislation

Announcing the favorable action of the sub-committee of the house committee on judiciary, general manager R. C. Marshall, Jr., outlined the steps that had been taken in advancing the day-labor bill at the hearing before the sub-committee and stated that copies of the full report of the testimony for and against the bill had been mailed to the members of the association. The next step, he pointed out, was to get the interest of the full committee on judiciary to the end that it would quickly report the bill out to the House of Representatives. If this was accomplished, he felt that there was reasonable expectation that the House would take action at the present session. It would be necessary, he insisted, for every member of the association to get in touch with his congressman and ask him to urge a favorable report by the judiciary committee and prompt consideration by the House. As a preliminary step, the members of the association on Tuesday evening (May 11) had as guests at an informal dinner some thirty members of Congress and here the reasons for and the requirements of the bill were outlined. In view of the progress so far and the interest manifested by House members in all instances where they had been approached personally, the association executives announced that there was reasonable hope of the enactment if contractors generally would meet their congressmen and explain the ends sought by it. In closing the discussion of day-labor legislation a resolution was voted disputing emphatically assertions which had been made in the sub-committee hearings that Federal bureaus needed the right to construct by day-labor to combat the evil of pooling and collusion in contract work. A discussion of the report of the hearings is reserved for another occasion.

In the matter of co-operative effort by the associated surety companies

(Concluded on p. 828)

Engineering Fifty Years Ago

From *Engineering News*, May, 1876

Contract Work

AT FIRST sight, it might appear that there was no need for the contractor. In early days, and perhaps we may say in comparatively barbarous times, great works were doubtless executed without the intervention of the contractor. He is an inevitable product of civilization; for inevitably, with civilization comes the division of labor. It is obvious that one of the main advantages of doing work by contract, and through the agency of a practiced contractor, is that you command the knowledge and experience of a trained body of men, fitted for the especial work.

It might be said, that at first sight, it does not appear why those who have undertaken a great public work, should not execute it by means of their own officers; but almost all experience shows that this would not be a wise course. There are many reasons for this conclusion, and some of them are based upon much knowledge of human nature.

It may serve to show the need and value of this system of contracting for great works, that it perpetually tends to extend itself. The great contractor finds it to his advantage to sub-let portions of his contract; and these are again sub-let to smaller men, by which means individual skill and exertion are gradually developed to the uttermost. Perhaps in no way could this individual skill and exertion be more amply developed, and the merits of individual men be brought more prominently forward than by this system of contracting. Moreover, it develops the power of bearing responsibility, and tends to create masters out of men.

Fire Protection Men Discuss Safety Provisions

Atlantic City Meeting of N. F. P. A. Approves Fire Test and Exit Specifications

(Special Correspondence)

The thirtieth annual meeting of the National Fire Protection Association, held May 10 to 13, at Atlantic City, N. J., was the best attended in the history of the organization, the registration exceeding five hundred. The work of this association, like other technical bodies, has grown to such an extent that it became necessary to devote four days to the meeting instead of three as in previous years.

The address of the president, Rudolph P. Miller, on the Relation of Fire Prevention to Zoning, evoked some discussion of the adverse attitude of the courts, notably those of New Jersey, Maryland and Wisconsin, toward restriction against business uses in residence districts and the necessity of gathering authentic and convincing figures to establish the increased fire hazard due to the presence of stores in dwelling houses.

Other formal addresses were, United States Government Service to the Merchant Marine, by J. Walter Drake, assistant secretary, U. S. Department of Commerce, outlining chiefly the activities of that department in promoting foreign commerce; and Fire Protection of Oil Properties, by C. H. Haupt, chief engineer, Standard Oil Company of New Jersey, describing present-day practice in the design, maintenance and operation of the storage and distributing plants of the oil industry.

Committee Reports

The twenty or more reports of the technical committees, the majority of which recommended more or less extensive revision of existing standards, were received and adopted with little discussion. The provision in the "Suggested Flammable Liquids Ordinance" dealing with the location and minimum spacing of above-ground storage tanks with respect to adjoining properties was the subject of much debate before adoption, as was also the inclusion in the revised National Electric Code of the specifications for non-metallic sheathed cable. The proposal to provide in the Automatic Sprinkler regulations for 8-in. supply lines serving 400 heads was referred back to the committee for further consideration.

New Specifications

New tentative standards and regulations as offered by respective committees were approved as follows: for gasoline trucks (Flammable Liquids Committee), for vaults and vault doors (Committee on Protection of Records), for gravity and pressure tanks (com-

plete revision of an existing standard by the Committee on Tanks), and for industrial buildings of reinforced concrete and slow-burning heavy timber construction (Committee on Building Construction).

Specifications for fire tests, outlining the procedure for the testing of columns, floors, walls and other structural elements of buildings and the conditions of acceptance for classification according to period of fire resistance, were accepted for submission to the American Engineering Standards Committee as an American standard.

The Committee on Safety to Life, which with an enlargement of its personnel constitutes the Building Exits Code Sectional Committee of the American Engineering Standards Committee, reported new provisions for exits and exit drills in hospitals and received authority to submit the same with revised earlier recommendations on other occupancies for approval as American standard.

Reports of the field engineers indicate that the association's efforts to decrease local fire hazards by the organization of fire prevention committees co-operating with public officials in municipalities throughout the country are meeting with success. The entire time of one engineer is devoted to securing uniform practice in electrical installations by the adoption and proper interpretation of the National Electric Code and the gathering of information for the improvement or elaboration of that code.

Dana Pierce, president of Underwriters' Laboratories, Chicago, was elected president for the coming year. Franklin H. Wentworth, Boston, and Albert T. Bell, Atlantic City, were re-elected, respectively, secretary and chairman of executive committee.

Work Starts on Port Project on Hudson River at Albany, N. Y.

The first step in the actual construction of a seaport on the Hudson River at Albany, N. Y., was taken on May 7, when the Albany Port District Commission let a contract to the Great Lakes Dredge & Dock Co. for dredging within the port area. The amount of the contract is $402,000. On May 11 the commission filed plans with the superintendent of buildings at Albany and received a permit, authorizing the erection of timber bulkheads on Westerlo Island at an estimated cost of $702,000. Bids on this work will be opened on May 21. The commission also has asked for bids on the manufacture of 2,700,000 concrete blocks and for 10,000 bbl. of cement.

Railway Electrification Limit at New York City Extended

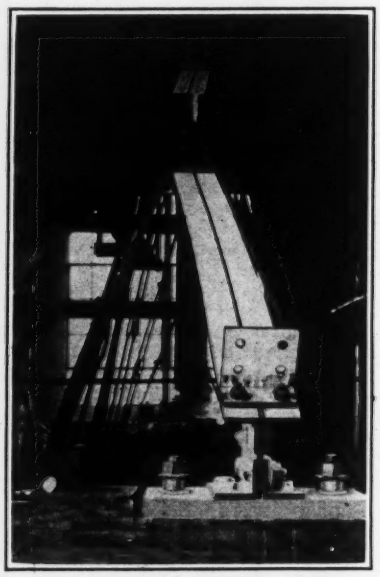
Governor Smith of New York has signed the bill amending the public service commission law in regard to railroad electrification within the limits of New York City. As amended the law authorized the commission to extend the time in which any railroad must complete the electrification of its lines until Jan. 1, 1931.

Riveted and Welded Trusses Tested to Failure

Gas-Welded Roof Trusses of 40 Ft. Span Compare Favorably with Similar Riveted Truss

A series of load tests of gas-welded and riveted roof trusses was carried out last week at the Buffalo plant of the Linde Air Products Co. Remarkably uniform results were obtained. The welded trusses developed slightly higher strength than the riveted.

One riveted and three welded trusses of equal dimensions and form were included in the program. They were



TEST TRUSS AFTER FAILURE

8-panel Fink trusses of 40 ft. span and 10 ft. rise, made up of angles, except that one of the welded trusses was made up of pipe. The angle trusses had rafters or top chords of two 3x2½x¼-in. angles and bottom chords of two 2x2x¼-in. angles, while the web members were either single or double angles; their gusset plates were ⅛ in. to ¼ in. thick for the riveted truss and ⅜ in. (two ¼-in. plates) for the welded trusses. The pipe truss was built of 3-in. and 2½-in. standard pipe for the chords, and 2-in. and 1½-in. pipe for the web members, with gusset plates welded into slots in the pipes at the main panel points. All welded connections were made with oxy-acetylene torch; the joining edges were not beveled.

For test, each truss was set on rocker supports on two concrete pedestals, one of which was fitted with roller expansion bearing above the rocker. The truss was stayed laterally against tipping or top-chord buckling by short purlins loosely bolted to timber gantry frames straddling the test area. Loads were applied by piling pig iron on platforms hung from stirrups passing over the truss rafter at the panel points. Deflections and strains were read at various loads.

Failure occurred in all cases by buckling of the rafter (see photograph of typical instance), the major buckling occurring between purlins, though some lateral yielding of the gantry frames was also evident. Deflections of the trusses and strains in the members were closely proportional to the loads.

The following failure loads were reached:

	Panel load, lb.
Riveted truss	9,000
Welded angle trusses, 10,300; 10,000	
Welded pipe truss	9,000

Lüder lines began to appear around some panel-point connections and especially near the heel of the rafter a short time before maximum load was reached, but there was no evidence of approach of the yield-point elsewhere. The nominal or rated load capacity of the trusses was 3,000 lb. per panel, corresponding to tensile stresses of about 14,000 lb. per sq.in. net section (of the riveted truss) and compressive stresses of 9,000 lb. per sq.in. gross section.

A full report on the tests is to be made public shortly by the company.

145-Mile Railroad Line in Texas Authorized by Commission

The Interstate Commerce Commission has authorized the Chicago, Rock Island & Pacific Railway Co. to construct a railway line from Liberal, Kan., a point near the Kansas-Oklahoma boundary through Texas County, Okla., and through Hansford, Hutchinson, Carson, and Potter Counties in Texas to Amarillo, a distance of approximately 145 miles. The application was opposed by the Atchison, Topeka & Santa Fe Railway Co. and by the Beaver, Mead & Englewood Railroad Co. on the basis that the projected line would divert traffic from the lines of both railroads, and (by the Santa Fe) on the grounds that as the Rock Island was not chartered in the State of Texas it could not construct a railroad line there.

The Rock Island states in its application that it not only expects to use this line for developing traffic from a territory which is now lacking in adequate railroad facilities, but also to use it as a second main track for handling its through trans-continental traffic.

Nominees Named to Head A.A.E. Ticket

The following members of the American Association of Engineers have been placed in nomination as officers and directors; the vote will be canvassed at the Philadelphia Convention, June 13 to 19: President, C. J. Ullrich and George E. Taylor; first vice-president, W. R. Harris, L. H. Gardner and O. Laurgaard; second vice-president, D. M. Baker, A. M. Knowles; Directors, District 2, J. M. Buswell and Paul Ehlers, District 3, C. W. Cross, District 6, Victor Cochrane, District 8, S. C. McKee, District 9, H. G. Culverhouse, District 11, E. G. Haines, District 12, J. F. Dennison and Harrison P. Eddy (alternate). Messrs. Culverhouse, Cross, Dennison and Eddy were named by the Board of Direction, the others by petition.

WASHINGTON NOTES

THE Chief of Engineers has announced that he is anxious to do by contract as much as possible of the work on the Missouri and on the Mississippi between St. Louis and Cairo. If arrangements cannot be made to do most of the work on those projects by contract, it will be necessary for the Corps of Engineers to invest heavily in additional equipment, General Taylor states.

A LICENSE has been granted by the Federal Power Commission to the Northwestern Power and Light Co. of San Francisco, covering a development on the Elwha River in Clallam county, Wash. The plans call for a concrete arch dam 195 ft. in height, a tunnel 530 ft. long, and the installation of 12,000 kw. Power is to be fed into the company's existing system. The reservoir will provide 20,000 acre-ft. storage.

AS AGREED to in conference the air commerce bill requires the registration of aircraft engaged in the interstate transportation of persons or property for hire; in the furtherance of a business and in the operation of a business.

By the furtherance of a business is meant such operation as the transportation by air of factory products from the main plant to a branch office, or the use of aircraft by professional men while traveling on business. By operation of a business is meant such activity as the gypsy flier who goes from place to place giving exhibitions.

Aircraft are eligible for registration only when owned by a citizen of the United States. If the owner is a corporation fifty-one per cent of the voting stock must be owned in this country.

The Secretary of Commerce is required to provide for the examination and rating of registered aircraft as to their air-worthiness and to establish air traffic rules for the navigation, protection and identification of all aircraft. These regulations are to apply to non-commercial flying.

Foreign aircraft may not engage in interstate or intrastate commerce but may engage in all other air navigation.

The Secretary of Commerce is to install lights, signal stations, directional finding facilities, and radio communication facilities along air routes. He is also to chart the airways.

The bill provides public right to air navigation in navigable air space similar to the public right of navigation upon navigable waters. It provides for the appointment of an assistant Secretary of Commerce to have immediate charge of commercial aviation.

THE Federal Power Commission has authorized the issuance of a preliminary permit to Dexter P. Cooper, Inc., of Eastport, Me., covering a proposed development of tidal power in Passamaquoddy and Cobs Cook Bays, Maine. The development will affect the St. Croix River and lands and waters in the Province of New Brunswick.

It is proposed to construct dams between various islands and between islands and the main land so as to divide the waters the two bays into two pools. It is intended that water will flow from the ocean through forty-three gates into the upper pool and pass to the lower pool through the power house. The lower pool will be emptied into the ocean through thirty gates when the tide is falling.

Mr. Cooper expects to obtain a mean operating head of 13 ft. between the pool and with a flow of 300,000 sec. ft. expects to develop 2,500,000,000 kw.-hr. annually, with an installed capacity of 600,000 hp. Navigation is to be provided for between the upper pool and the ocean by one large lock and one small lock and between the ocean and the lower pool by one small lock. The Chief of Engineers has stipulated conditions wihch will safeguard the interests of navigation.

With this permit Mr. Cooper now will be in a position to take up the matter of securing Canadian approval of the project.

Los Angeles Aqueduct Dynamited

On May 13 the Los Angeles Aqueduct was dynamited near Lone Pine, 180 miles north of Los Angeles. The canal here is an excavated ditch 11 ft. wide at the bottom, 10 ft. deep and 30 ft. wide at the top. The explosion is reported to have torn a circular hole 10 ft. in diameter. William Mulholland, chief engineer, reports: "Dynamite caused breach in concrete lining on side and bottom of canal, which was completely repaired and water turned in again twenty-four hours later."

This is the third interference with the aqueduct supply. In May two years ago the aqueduct was dynamited near this spot and in November that year Owens Valley residents seized the gates and diverted the flow.

To Resume Work on Power Plant at Grand Falls, N. B.

Work on the development of hydro-electric power on the St. John River at Grand Falls, N. B., which was indefinitely postponed when a change of government upset the plans the development of power by the province, is to be resumed. Development will be by private capital, by the International Paper Co. through the St. John River Power Co., which must start construction within six months unless given an extension of time by the government. Under the agreement the International Paper Co. will build a 200-ton paper mill and, if there is sufficient power after making reservations for other use within the province, the mill capacity will be increased to 700 tons in the future. By agreement with the Fraser Companies, Ltd., a block of 13,000 hp. primary and 7,000 hp. secondary power is reserved for their use.

This project was approved by the International Joint Commission in June, 1925. (*Engineering News-Record* July 9, 1925, p. 78.)

RANDOM LINES

Vile Words

Managers of skyscrapers are entitled to special distinction, the National Association of Building Owners and Managers has decided. As a result it is seeking a name to describe properly the numerous duties involved in running a building whose occupants number more than some of the country's smaller cities. As an example of what is desired, the directors of the contest point to two words already offered—skyscrapators and buildagers.—A. P. *Dispatch.*

* * *

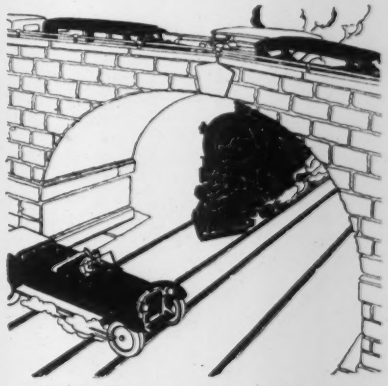
Even This

The two correspondents to the Baltimore *Sun* and the Springfield *Republican*, respectively, are agreed on definition, at any rate:

(a) "Prohibition was not put through by teetotalers, but by an assorted body of citizens who saw in prohibition a desirable social engineering project."

(b) "Prohibition was planned and constructed by ignorant and fanatical social engineers. . . . As a social engineer, and reconstructor of human nature, the efforts of Volstead have proven a national calamity."

* * *



Why Have An Arch Ring?

Sir—I am enclosing herewith an advertisement from the *Nation's Business* for May, 1926. It strikes me that the use of this "arch" would be just about as hazardous an undertaking as crossing the tracks at grade or more so.

R. D. G.

* * *

Recent Additions

(171) *Tire Engineers*—"Let our —— —— solve your tire problems"—Hagner Tire Stores, San Antonio, Texas.

(171) *Air Engineers* — Atlanta Blow Pipe Co., Atlanta, Ga.

(172) *Arctic Engineer*—"Robert Pope, arctic engineer, to be associated with flight to pole."—Washington *News.*

(173) *Demolition Engineer*—One Frederick Swank, who according to the San Francisco *Chronicle*, raised a sunken vessel at Avon, Calif.

Road Builders Hold Their Annual Meeting

Association's Attitude Toward Safety Outlined—Efficiency Needed for Future Work

The American Road Builders Association held its annual meeting in New York May 14, heard reports of the treasurer and of the manager of the Road Show and installed its new officers. The treasurer's report showed that the show last January had netted $43,069, and that the surplus of the Association is $89,022, of which $84,773 is in cash and government securities. Out of the available funds the board of directors have voted approximately $25,000 for the publication of a condensed catalog of the machinery and materials of the manufacturers who exhibited at the show. This catalog will be distributed free.

In his closing address the retiring president, W. H. Connell, engineering executive of the Pennsylvania Department of Highways, stated that the association had slighted the highway safety problem, and it should become an important influence in lessening highway accident. Accident reduction must be achieved by three methods he said: (1) By the elimination of bad features in highway location, such as steep grades, sharp curves and blind corners. (2) By installing adequate signals to warn of bad conditions day and night. (3) By adequate policing. Highway patrols should be at least doubled, and in many cases trebled in size.

He urged that the association advocate these safety measures.

Henry G. Shirley, chairman of the Virginia State Highway Commission, was installed as president. In his installation address he reviewed the influence that the association had had on the highway movement and pointed out that it had a tremendous task ahead. Approximately $12,000,000,000 must be spent on highway work in the next ten years, and the members of the association, he said, must assume responsibility for its efficient expenditure. He pointed out three detailed tasks for the association: (1) To settle the matter of regional meetings. (2) To study the finances of the organization, lay out a fiscal policy and make a budget so that the association's activities will be carried out in a business-like manner. (3) To collate and put into the hands of legislative authorities proper types of laws for the administration of highways.

Delegates to Milan Convention

The president was authorized to appoint delegates from the association to the Milan Convention of the International Road Congress. Delegates are to go at their own expense.

The officers installed (elected at Chicago in January) were: President, H. G. Shirley, chairman, State Highway Commission, Richmond, Va.; vice-president, W. R. Smith, president, Lane Construction Corp., Meriden, Conn; S. T. Henry, director, Pan-American Confederation for Highway Education, Spruce Pine, N. C.; S. F. Beatty, vice-president, Austin-Western Rd. Machy Co., Chicago, Ill.; Samuel Hill, honorary life president, Wash. State Good Rds. Assn., Seattle, Wash.; treasurer, James H. MacDonald, consulting road and paving expert, New Haven, Conn.; directors, R. Keith Compton, director of public works, Richmond, Va.; W. H. Kershaw, manager Asphalt Sales Dept., The Texas Co., New York City; Wm. Ogden, Lakewood Engineering Co., Cleveland, O.; C. M. Pinckney, chief engineer, Borough of Manhattan, New York City; Frederic A. Reimer, consulting civil engineer, East Orange, N. J.; Frank Terrace, President Wash. State Good Rds. Assn., Seattle, Wash.; C. M. Upham, state highway engineer, Raleigh, N. C.

Quantity Surveyors to Organize

A meeting for the organization of the American Institute of Quantity Surveyors is to be held at the Sherman Hotel, Chicago, June 7 to 9. Apart from the organization arrangements the program includes the following subjects for papers and discussions: History of Quantity Survey in America; Foreign Practice; Beneficial Effects Upon the Construction Industry; Uniform Systems; Cubage of Structures, G. Szmak; Should the Survey be a Tabulation of the Physical or Material Quantities, T. D. Mesler; Rules, Forms and Instruments, H. A. Sloane and F. H. Hunter; Units of Measurement, T. D. Mesler; Services, Rates and Employment, J. W. LeMay; Publicity and Sales Management. Local arrengements are in charge of C. T. Burman, Burman Quantity Bureau, Chicago.

Mountain Electrification on the Great Northern Ry.

For its 24-mile electrification across the Cascade range, between Cascade Tunnel and Skykomish, Wash., which includes the present 2½-mile tunnel, the Great Northern Ry. has ordered two double-unit locomotives and is about to order two more. The electrification work is under way. The railroad company also will place orders for the substation equipment necessary to enable it to take power from the Puget Sound Power & Light Co. under a contract executed recently in the expectation that electrification will be extended when the new 7¾-mile tunnel is completed. This latter tunnel was started in November, 1925.

O'Shaughnessy Dam at Columbus, Ohio, Dedicated

The new water-supply dam across the Scioto River at Columbus, Ohio, called the O'Shaughnessy Dam in honor of the late Jerry O'Shaughnessy who served the city as superintendent of its water works for many years, was dedicated on May 15. The dam has a maximum height to spillway level of 84 ft. and a length of 1,750 ft., about half masonry and half earth fills. Its storage capacity is 5,400 million gallons. This dam is not to be confused with the O'Shaughnessy dam of the Hetch Hetchy water supply project which was named after M. M. O'Shaughnessy sometime after the same name had been given to the dam at Columbus.

Mayor Vetoes Ordinance Lessening Tenement Restrictions

A zoning ordinance passed (17 to 6), by the city council of Milwaukee, Wis., lessening the area restrictions on apartment houses has been vetoed by Mayor D. W. Hoan. The new ordinance reduced the minimum area per family in a house on a 40x120-ft. lot from 2,178 to 600 sq.ft., thus permitting 8 instead of two families on a lot in the residential-business areas. The mayor declared that the new ordinance would break faith with those who had built under the present law. He also said: "If more residence space is needed, it is far more logical to designate some of the unbuilt area in business sections as residence districts rather than to park one family on top of another over a store. Such a bandbox arrangement provides no fit place for human beings to live. There is neither adequate light, sun, nor air, and there is no place for children to play except on the street."

General Contractors Board Meets at Washington

(*Concluded from p. 825*)

little progress was reported. In respect to uniform questionnaires, however, notable progress was announced by S. M. Williams of the joint conference. Reasonable increase in the use of the questionnaires was observed but more important were the facts that they had been endorsed by the clearing house section of the bankers association and by the credit men's association. With these powerful influences for the standard questionnaire Mr. Williams expressed hope that its use would increase.

Quantity Surveys

Increase in quantity survey bureaus directed by or affiliated with A.G.C. chapters prompted active discussion whether state-wide surveys were practicable and whether control should be kept in A.G.C. hands or permitted to pass into the hands of commercial surveyors. The discussion indicated the following trends of opinion: (1) Quantity-survey bureaus directed by chapters have been generally used and are successful, (2) the most of these bureaus are local but there are some of state-wide operation as in Taxas and these have functioned with no trouble, (3) beyond all doubt the control of quantity survey service, whether by affiliation or by ownership, should be held by A.G.C. chapters.

Licensing Contractors

This subject was brought up for consideration by the statement that, besides North Carolina, which had a law over a year old, New Jersey and South Carolina had laws in their legislatures and similar statutes were contemplated or being advanced in other states. In view of the movement it was felt that A.G.C. members needed to arrange their convictions and be prepared to direct thought as the question arose.

The members selected Kansas City, Mo., as the place for the fall meeting.

Railway in Illinois Authorized

The Interstate Commerce Commission has authorized the St. Louis Connecting Railroad Co. to construct a double-track line extending from a connection with the Pittsburgh, Cincinnati, Chicago & St. Louis Railroad Co. at a point near Collinsville, Ill., in a northeasterly direction, to a point on the same line 2 miles west of the village of St. Jacob, Ill., a distance of 9.2 miles. All the stock of the new railroad company is to be owned by the Pennsylvania Railroad Co. Construction is to start before Dec. 31, 1926.

State Housing Bill Becomes Law in New York

The housing law of New York State has been signed by the Governor. It sets up a state housing board to study housing conditions and gives the board power to obtain by condemnation real estate for the use of "limited dividend corporations" in building tenement houses. The law sets up a maximum limit for the rental per room in such houses, specifies the dividends which the corporation may pay and prescribes its organization and financial structure in detail.

Nominations of Testing Materials Society Announced

Announcement has just been made of the following official nominations for the officers of the American Society for Testing Materials: President, J. H. Gibboney, chief chemist, Norfolk and Western Ry. Co., Roanoke, Va.; vice-president, G. W. Thompson, chief chemist, National Lead Co., 105 York St., Brooklyn, N. Y.; for members of executive committee, Cloyd M. Chapman, consulting engineer, 105 West 40th St., New York City; W. F. Edwards, director of research, United States Testing Co., Inc., 316 Hudson St., New York City; W. B. Price, chief chemist and metallurgist, Scovill Manufacturing Co., Waterbury, Conn.; and H. T. Shelley, secretary and manager, Eastern Clay Products Association, 906 Colonial Trust Bldg., Philadelphia, Pa.

American Construction Council Governors Meet

The Board of Governors of the American Construction Council met May 14 in New York City in the office of Franklin D. Roosevelt, president of the Council. Eighteen members were present. Dwight L. Hoopingarner, executive, reported progress since last Fall along two lines—considerable interest in the recent pamphlet "Six Steps in Building or Buying a Home," and the receipt of a number of pledges toward the permanent financing of the council's work.

Plans for promoting the teaching of the business of construction in universities, for proper city planning of the smaller towns and villages, and for the issuance of a pamphlet for the individual investor on building investment were approved as future activities for the council and committees appointed.

Engineering Societies

Calendar

Annual Meetings

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Buffalo, N. Y., June 5 and 7, 1926.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., June 7-11, 1926.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Philadelphia, Pa., June 13-19, 1926.

SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, State University of Iowa, Iowa City, June 16-18, 1926.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J.; June 21-25, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Summer Meeting, Seattle, Wash., July 14-16; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

Personal Notes

CHARLES M. UPHAM, state highway engineer of North Carolina, and director of the Highway Research Board of the National Research Council, has been appointed by the Federal Highway Commission of Mexico to take charge of the reorganization of the Construction Department of the commission. Mr. Upham has heretofore acted as consulting engineer in the organization of the federal Engineering Department of Mexico.

E. H. SCHULZ, colonel, Corps of Engineers, U. S. Army, has been assigned to Chicago as district engineer to relieve Maj. Rufus W. Putnam, resigned to take charge of Chicago harbor investigation. Colonel Schulz is now on two months interim leave following his assignment with the Third Corps in Honolulu and will relieve Major Putnam July 1. He is also to be engineer on the staff of the commanding officer of the Sixth Corps Area and reports for this position June 1.

RICHARD F. A. MULLER, Washington, D. C., was recently made technical director of the Latin-American department of Newell, Corse & McDaniel, of Washington. Mr. Muller was formerly consulting engineer to the government at Ecuador, previous to which he had assisted in organizing the school of engineering in the University of Quito and had taught there six years. In 1924 he was the Ecuadorian representative in the Pan-American Highway Commission which visited the United States.

JOHN F. RICHARDSON, superintendent of the Newlands land reclamation project, has resigned to accept a position in Mexico with the J. G. White Engineering Corporation. D. J. Stuver has been designated acting superintendent of the Newlands project.

F. M. SLOANE has been appointed district engineer for the middle district of the Chicago, Milwaukee & St. Paul Ry., with headquarters at Milwaukee, Wis.

C. U. SMITH, district engineer of the Chicago, Milwaukee & St. Paul Ry. at Milwaukee, Wis., has resigned to take a position with the city of Milwaukee.

CHARLES HAYDOCK has been appointed chief engineer of the engineering firm of Gannett, Seelye & Fleming, Inc., of Harrisburg, Pa. Mr. Haydock was formerly principal assistant engineer of the Pennsylvania Railroad Co.'s water-supply system.

FRANK MERRITT, chief engineer, Gulf, Colorado & Santa Fé Railway Co., was seriously injured in the fall of an elevator in the Court House at Dallas, Tex., recently.

GEORGE H. EVELAND has resigned as assistant engineer, Pacific Gas & Electric Co., to join the staff of the Constant Angle Arch Dam Co. of San Francisco, where he will be designing engineer for the power plant and substation on the Buck's Creek high-head power development of the Feather River Power Co.

DANIEL H. B. STARR, assistant division engineer at Norwich, Conn., on highway work, has been appointed division engineer of the new highway division established with Middletown, Conn., as headquarters, the new division comprising twenty-six towns in Hartford, New Haven and Middlesex Counties. JOHN SOEHRENS, resident engineer of the former Middletown branch office, has been appointed assistant division engineer of the new Middeltown division. Both appointments are effective June 1.

WILLIAM G. DUVALL, Denver, Colo. chairman of the Colorado highway advisory board, who received his initial appointment when the governor of Colorado appointed him to fill the vacancy caused by the death of the former chairman, John A. Donovan, has been reappointed for a three-year term.

Obituary

JOSEPH W. GALBREATH, of Bedford, Pa., formerly chief engineer of the Western Maryland R.R., died recently, in a hospital in Elizabeth, N. J. Mr. Galbreath was formerly connected with the Pennsylvania R.R. and lived at Rahway, N. J., and in 1916 was made a member of the supervisory force of the New York Dock Co.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Mixer Manufacturers Bureau Adopts By-Laws

Action Expected to Assist Bureau in Present Work and Enable It to Widen Its Activities

MOST important of the actions taken at the meeting of the Mixer Manufacturers Bureau of the Associated General Contractors held May 5 at Chicago was the adoption of a set of by-laws for the government of the bureau. These by-laws had been presented at the April 8 meeting, also held at Chicago, and were there referred to a committee for final revision.

Since its formation in 1924, the Mixer Manufacturers Bureau has been governed largely by stipulations put into the minutes of its first meeting. This condition has in some cases been a handicap and the set of by-laws was designed to expedite the bureau's work and at the same time furnish a thoroughly organized machinery which should enable the bureau to widen the scope of its activities.

The question of the substitution of a 10-E paver for the present 7-E machine was again given consideration, but no action was taken. The problem was assigned to the technical committee with instructions that a report be made to the bureau at its next meeting to be held within 30 days at Chicago.

A problem has arisen in connection with the attempt to provide a mixer capable of delivering a two-bag batch of 1:2:4 concrete. At first it was proposed to substitute a 10-E machine in place of both the 7-E and 13-E machines. However, it was found that in many cases the 13-E machine is ideal for paving work in cities where steep grades and narrow streets are encountered, and in view of this it was finally proposed that the 10-E machine be adopted as standard beginning with 1927 and that the present standard 7-E machine be discontinued. As stated, the question has again been referred to the technical committee for a report.

The election of a new board of governors and appointment of new committees were postponed until the next meeting.

A resolution based upon suggestions made by the committee appointed to consider the advertising of the bureau's activities was adopted. This appropriated $2,000 to be expended in the purchase of advertising space.

As set forth in the newly adopted by-laws, the special aims of the bureau are three in number: (1) To effect a standardization of construction and paving mixers embodying the principles of simplification of sizes and standardization of capacities and certain mechanical features. (2) To promulgate standard practices in the advertising and sale of products, in so far as is legally allowable and in accord with the best ethical practice and conduct of present-day business. (3) To pursue such other activities as may lead to economies in production, better service to the consumer, and the increase of knowledge in the manufacture of safer and more efficient products. An abstract of some of the main points covered in the by-laws is worth while and given below:

Membership — Any manufacturer of construction or paving mixers may become a member of the bureau by signifying his intentions in writing and provided that such manufacturer shall have been elected to membership by the board of governors.

Administration — The affairs of the bureau shall be conducted by its officers assisted by a board of governors consisting of a chairman and four members. The board shall appoint a treasurer and a secretary, the latter to have an office adjacent to the office of the Associated General Contractors of America. The secretary is required to keep strictly confidential all information in his possession in regard to the sales and individual business of each member. The technical committee appointed by the board shall have charge of all studies of a technical nature.

Elections—The term of office of the members of the board shall be two years, while the chairman of the board shall serve as such for one year.

Meetings — The annual meeting of the full membership shall be held during the first quarter of each year. Special meetings may be called at any time by three members of the board or by four members of the bureau.

Financing—The bureau shall receive funds through special assessments and from charges, in excess of actual cost, for name plates furnished by the A.G.C.

Modifications of Concrete Mixer Standards—Mixer standards may be added to or modified by a two-thirds vote of the total membership of the bureau. Any modifications or additions to the concrete mixer standards shall not be in effect until approved by the Executive Board of the A.G.C.

Expulsion and Suspension — Any member may be suspended or expelled by a four-fifths vote of the board of governors subject to a majority of members present at next meeting. A member shall become liable to suspension or expulsion for failure to abide by the by-laws, abide by the concrete mixer standards, or abide by any other rule adopted by the bureau.

Business Notes

EISEMANN MAGNETO CORP., New York City, announces that Edward J. Goggins, formerly credit manager, has joined the sales force to cover the southeastern territory. Stephen M. Cargill, Jr., formerly of the R. G. Dun Commercial Agency, becomes credit manager.

T. L. SMITH CO., Milwaukee, Wis., announces the appointment of the following distributors: Coast Machinery Corp., San Francisco; LaLance Equipment Co., Huntington, W. Va., for southern West Virginia; J. Z. Horter Co., Havana, Cuba, with a territory comprising all of Cuba.

UEHLING INSTRUMENT CO., Paterson, N. J., manufacturers of power plant instruments, has appointed Henry Eggelhof, P. O. Box 945, Dallas, Texas, as representative for the eastern half of Texas.

UNITED STATES CAST IRON PIPE & FOUNDRY CO., Burlington, N. J., is now in a position to furnish cast-iron pipe centrifugally formed by the deLavaud process in sizes from 4 to 20 in. This announcement follows the completion and the successful operation for some months of the new foundry at the Burlington plant. This foundry will eventually house 18 deLavaud machines, half of which are now in operation. The rights to use the deLavaud patents are held by the United States Cast Iron Pipe and Foundry Co.

PARKER S. BOOKWALTER has been appointed Ohio state manager for the American Vibrolithic Corp., Des Moines, Iowa. Mr. Bookwalter's office is at 812 Harries Building, Dayton, Ohio.

Equipment and Materials

Large Capacity Loader Uses Two Lines of Buckets

An elevating bucket loader having a loading capacity of 4 yd. per minute is a new product of the George Haiss Mfg. Co., Inc., New York City. The machine is equipped with crawler traction and has two strands of buckets operating on four chains; the total bucket width is 37 in. The loader is equipped with a 37-hp. Waukesha engine and a transmission box which incloses the clutches and gears. The tail shaft is 9 ft. long and the machine may be crowded into the pile with the slow speed mechanism at 39 in. per minute. The elevator unit is pivoted on an A frame and is equipped with

a raising and lowering device actuated by a hand wheel. The clearance under the spout is 10 ft. All the sprockets as well as the chain are of manganese steel.

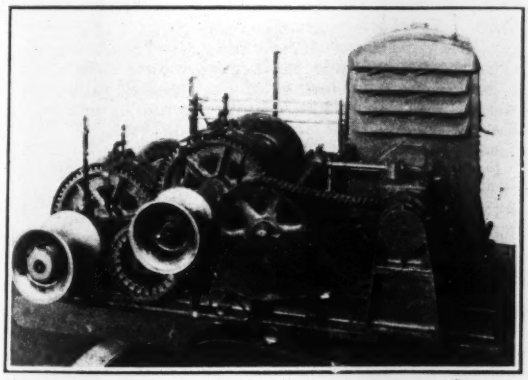
Alloy Steel Developed for Culvert Use

For its corrugated culverts, the Canton Culvert & Silo Co., Canton, Ohio, has adopted the new alloy steel developed by the United Alloy Steel Corp., Canton, Ohio, and known as Toncan copper molybdenum iron. Toncan iron was first produced about 18 years ago without alloys of any kind. In 1919, 0.2 per cent of copper was added in order to increase the rust resistance. Recently molybdenum was alloyed with copper in Toncan iron and the alloy is claimed to produce two or three times greater rust resisting qualities than does the copper alone. In addition, a greater tensile strength is claimed.

To identify Toncan copper molybdenum iron, the United Alloy Steel Corporation has adopted a slightly different detailed stencil of the brand whose use became effective April 1, 1926.

Hoists Use Three-Speed Sliding Gear Transmission

A most radical development in hoisting equipment design has just been made by the J. S. Mundy Hoisting Engine Co., Newark, N. J., in using a three-speed sliding gear transmission similar to that used in heavy motor truck service on its gasoline and electric hoists. The object of this application which has been patented in the United States and Canada is to provide the flexibility in operation that is required on construction jobs where both heavy and light equipment must be handled intermittently and often. The 60-hp. hoist has the following ratings, figured with five laps of cable on the drum—a slow speed of 180 ft. per minute with a line pull of 7,800 lb.; an intermediate speed of 270 ft. per minute with a line pull of 5,200 lb.; a high speed of 350 ft. per minute with a line pull of 4,000 lb.



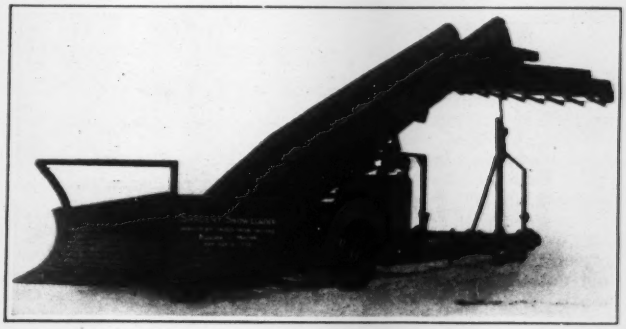
All gear shift and clutch levers are mounted, so that the operator does not have to move from his ordinary position. Gear shifting is accomplished as readily as it is on a motor truck and requires about 10 sec.

The gasoline hoist is built in standard sizes ranging from 20 to 75 hp., is equipped with automatic safety brakes, Waukesha four-cylinder power unit, silent chain drive and Alemite lubrication system. The drums are bronze bushed. The lateral thrust on the transmission box is taken by ball bearings from each side of the silent chain drive which runs in an oil-tight casing.

The electric three-speed hoist is built with General Electric motors and equipment and is available in sizes ranging from 20 to 100 hp. Larger sizes of both types of hoist are built as required.

New Snow Loader Is Combination Plow and Elevating Loader

A new snow loader has been developed by D. A. Sargent and the Union Iron Works of Bangor, Maine, which is designed not only to load the snow, but in addition to plow it. This provides a means of breaking up snow banks previously formed at the side of the road which have become frozen before there was an opportunity to remove them. Also the equipment may be operated directly following a snowfall.



The machine represents, in fact, the elevating grader principle applied to snow removal. The equipment has been in the process of development for about two years and has only now reached the desired point of perfection so that it will be on the market next winter.

The loader is built to operate with a 5-ton Caterpillar tractor which is run between the side frame members. The hitch is made under the drawbar of the tractor at the rear. The conveyor itself is run by a separate power unit.

The rear end of the loader is carried on runners; 85 per cent of the weight at the forward end is carried on either wheels or runners. The plow and conveyor may be raised 10 in. from the ground and means are also provided for raising or lowering the conveyor trough. Two men are required to operate the equipment, a tractor operator and a loader operator.

Many Improved Details Feature Revolving Tunnel Shovel

The Butler shovel that has been used in tunneling and mining operations for several years is now being manufactured by the Nordberg Mfg. Co., Milwaukee, Wis., and a number of important improvements on it have been made.

The shovel is a full revolving machine operated by a four-cylinder air engine. All the movements of the dipper assembly are supplied from one operating cylinder which is 10 in. in diameter with a 42-in. stroke. In this cylinder are two pistons acting together on the crowding or lifting motion of the dipper. For the digging and dumping motions the air is introduced between the pistons which forces them apart and then by means of cables and links imparts the motion to the dipper. It is claimed that the dipper when digging exerts most of its reaction against the floor of the tunnel thus preventing the strain from being imparted to the frame of the machine. The machine can rotate in a 5½-ft. width in a headroom of 6½ ft. with the dipper loaded and raised above the machine. At the extreme extension of the dipper a clean-up path 18½ ft. wide is possible. The dipper will clear a car 56 in. high.

Steel bars and rolled shapes have been substituted for the castings on the dipper arms and side frame. The shovel dumps the rock over the top rather than through the bottom as in the old model and in present models of power shovels. This permits the shovel to handle larger rock than formerly.

The hydraulic dash pots used to control the lifting stroke of the dipper on the old machine have been eliminated entirely on the new model.

Air consumption is claimed not to exceed 135 cu.ft. of air per minute at 70 to 90 lb. pressure. The dipper has a capacity of 7½ cu.ft. and the weight of the machine is about 4,000 lb. It is claimed that it can be lowered on a mine cage 36 in. x 54 in. without taking it apart and that the removal of the operator's platform reduces the width about 12 in.

Publications from the Construction Industry

Steel Window Sash—BOGERT & CARLOUGH CO., Paterson, N. J., has just published a 16-page catalog, G-26, describing its top and bottom sliding ventilator windows using bronze guides.

Electric Lighting Plant—UNIVERSAL MOTOR CO., Oshkosh, Wis., has made available a new catalog on its four-cylinder gasoline engine driven electric lighting plants ranging in capacity from 1½ to 12½ kw. The booklet describes the recent improvements in design and construction of each of the various models. Specifications are given for all the different types.

Elevating Graders — LITTLE RED WAGON MANUFACTURING CO., Omaha, Neb., devotes a new catalog to a description of all of the various details of its elevating graders. Illustrations are given of the details, as well as construction views of the graders at work.

Steam Shovel Data—MARION STEAM SHOVEL CO., Marion, Ohio, started in April the publication of a monthly bulletin which is called "The Ground Hog." It is stated that the object of this publication is to promote good will and mutual understanding between shovel operators and the Marion company. It is the plan to provide data of helpful interest in it each month.

Self-Loading Scrapers—BAKER MFG. CO., Springfield, Ill., has entitled its Bulletin No. 229 "Road Officials and Baker Maneys." The bulletin shows the use of the Baker-Maney self-loading scraper being used in conjunction with tractor and blade grader outfits in repairing and maintaining roads having many different ailments.

Concrete Mixers — KOEHRING CO., Milwaukee, Wis., devotes a new catalog to its 7-S concrete mixer. All its various details are illustrated and described in addition to the illustrations of various models available.

Ornamental Iron Work—BUILDING PRODUCTS CO., Toledo, Ohio, in a new catalog not only describes and illustrates its ornamental metal work for various uses in building construction, but also devotes some 30 pp. to line drawings of ironwork details for balustrades, posts, stair treads and risers, ladders, window guards and similar miscellaneous equipment.

Material Stackers—LEWIS-SHEPARD CO., Boston, Mass., has issued a 32-p. catalog describing its line of jack lifts, stackers and steel-leg platforms.

Concrete Mixers—THE FOOTE CO., Nunda, N. Y., has issued a small booklet entitled "Out of the Beaten Path" in which it features the use of Timken roller bearings and the improved lubrication on its new 27-E concrete mixer.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
May 20, 1926	$32,192,000	$37,975,000	$70,167,000
May 13, 1926	18,368,000	34,371,000	52,739,000
May 21, 1925	22,754,000	12,298,000	35,052,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	382,493,000	680,849,000	1,063,342,000
1925	378,583,000	505,911,000	884,494,000

New York City Awards Equal Last Year's Value

THIS year *Engineering News-Record* has published news of 166 contracts worth $124,318,000, in New York City, compared with last year's 180, worth $124,595,000. These contracts are of the following minimum costs: water-works and excavations, $15,000; other public works, $25,000; industrial buildings, $40,000; commercial and other buildings, $150,000.

It can be seen from the accompanying tabulation that marked gains in lettings for apartment houses, hospitals, office buildings, clubs, warehouses, baths, banks, exchanges, garages and subways brought the 1926 total close to that of the first four months of last year. The buildings just mentioned, exclusive of apartments, hospitals and offices, are classed as "other buildings" in the table. In total number of projects, April was the heaviest for that month in any year since the building boom began.

New York City Contracts Reported By E. N.-R. In First Four Months of 1925 and 1926

	1925		1926	
	No.	Value	No.	Value
Water-works	16	$3,298,000	13	$371,000
Sewers	15	3,105,000	8	565,000
Bridges	2	2,734,000	1	104,000
Excavation	2	54,000	1	10,000
Streets	34	7,423,000	16	5,253,000
Industrial buildings	8	5,385,000	9	1,035,000
Apartments	33	10,805,000	39	19,825,000
Hotels	3	10,900,000	6	7,975,000
Schools	19	12,047,000	9	3,286,000
Theatres	7	21,300,000	5	3,925,000
Churches	2	6,200,000	3	2,650,000
Lofts	5	7,800,000	3	3,700,000
Hospitals	5	4,277,000	5	5,450,000
Offices	7	19,800,000	14	38,950,000
Other buildings	8	3,087,000	14	7,750,000
Federal gov't	3	230,000	1	19,000
Subways	7	5,931,000	13	22,855,000
Unclassified	4	219,000	6	595,000
	180	$124,595,000	166	$124,318,000

Building trades wage controversies are prevalent in seventeen municipalities throughout the country. Aside from existing strikes among furriers and shoemakers, New York City is singularly free from labor troubles, although the wage schedules for skilled building mechanics are higher than for any other city in the land. Considering these facts and also that proposed work is in larger volume than at this time last year, the present rate of construction activity should extend to the end of the current quarter.

Seventeen Localities Where Labor Troubles Prevail

Locality	Craft	Present Wage Per Hr.	Rate Demanded Per Hr.
Chicago, Ill.	Plasterers	$1.50	$1.75
Kansas City, Mo.	Carpenters	1.12½	1.25
	Tile marble setters' helpers	.82½	1.00
	Hoisting engineers	1.12½	1.25
Holyoke, Mass.	Mason tenders	.87½	1.00
Indianapolis, Ind.	Bricklayers	1.50	1.62½
Syracuse, N. Y.	Jurisdictional dispute between bricklayers and plasterers; latter on strike		
Lockport, N. Y.	Plumbers	1.00	1.25
Providence, R. I.	Bricklayers	....	1.50
Batavia, N. Y.	Plumbers	1.00	1.12½
Toledo, O.	Plasterers	1.50	1.75
Paterson, N. J.	Plumbers	1.25	1.50
	Steamfitters	1.25	1.50
	Gasfitters	1.25	1.50
Cleveland, O.	Painters	1.25	1.37½
	Glaziers	1.25	1.37½
	Common laborers	.87½	1.00
San Francisco, Calif.	Carpenters walk-out; demand closed shop		
St. Louis, Mo.	Painters	1.30	1.37½
	Asbestos workers	1.25	1.42½
Philadelphia, Pa.	Electricians	....	1.37½
Boston, Mass.	Bricklayers; State Board of Conciliation and Arbitration investigating strike		
Aberdeen, Wash.	Carpenters	.....	1.12½
Hoquiam, Wash.	Carpenters	.....	1.12½

Imported Construction Materials Gaining Headway in U. S.

Exports Still in Lead but General Direction Is Toward Import Balances in Our Foreign Trade

THAT imports are slowly approaching the export level in shipments of construction materials and equipment as well as in general foreign trade, is indicated in the recent report of the Foreign Commerce Dept. of the Chamber of Commerce of the U. S. on 1925 volume as compared with that of the year preceding.

We exported construction materials and equipment to the value of $301,699,000 in 1925 as against $298,123,000 for the year preceding, a gain of approximately one per cent. Imports during that period in this particular class amounted to $125,400,000 as compared with $111,524,000 for the year 1924, a gain of over 12 per cent.

Total exports, all classes of goods, amounted to $4,909,000,000 in 1925, against imports valued at $4,228,000,000. The 1925 imports were heavier than for any other year except 1920.

Increases in value, comparing 1925 exports with those of the previous year, included wooden doors, 107 per cent; paints, stains, etc., 33.8 per cent; freight cars, 31.4 per cent; locomotives, 24.3 per cent; natural asphalt and bitumen, 33.3 per cent; construction and conveying machinery, 20.5 per cent; railway ties, 16 per cent; and cement, 15.3 per cent.

Comparison of import values, 1925 with 1924, shows important gains as follows: pig iron, 112.5 per cent; cement, 87 per cent; iron and steel pipe and other tubular products, 74 per cent; steel ingots, bars, etc., 53.3 per cent; structural shapes and building forms of iron and steel, 47.3 per cent.

Exports greatly exceeded imports in our commerce with Great Britain, Canada, Germany, France, Italy, Argentina, Australia, Holland, Belgium, Spain, Russia, Denmark, British South Africa, Sweden, New Zealand and Panama. Imports exceeded exports in the trade with Japan, Cuba, Mexico, China, Brazil, Philippine Islands, Colombia, Chile and British India.

March returns show declines, compared with the month preceding, in the following imports: Pig iron; scrap; ferro-manganese and alloys; steel ingots, etc.; sheets; skelp, etc.; cast-iron pipe; barbed wire; and wire rods. Gains were noted in the following March imports: Steel bars; hoops; bands; structural shapes; steel rails, etc.; pipes and tubes other than cast-iron; round iron and steel wire; flat wire; and strip steel. Recent trade reports disclose an excess of imports over exports for three successive months

Comparison of 1925 Import and Export Values of Several of the Most Important Construction Materials

	Value In 1925		Per Cent Gain (+) or Loss (—) in Imports Compared with Exports
	Imports	Exports	
Cement	$5,814,000	$3,003,000	+93
Steel bars, etc.	4,643,000*	9,815,000	—53
Iron and steel pipe and other tubular products	4,726,000	29,543,000	—84
Structural shapes and building forms of iron and steel	2,863,000	11,839,000	—76
Steel rails	1,053,000	6,155,000	—84
Boards, planks, etc.	56,812,000	83,026,000	—32
Logs and timbers	3,855,000	21,338,000	—82
Brick	176,764†	194,153‡	—9

* Including ingots. †Including crucibles. ‡ Including hollow tile.

Comparison of Imports and Exports of Principal Construction Materials and Equipment In 1925 and 1924

Imports

Material	1925 Thousand Pounds	1925 Value	1924 Thousand Pounds	1924 Value	Per Cent Gain (+) or Loss (—) in Value During 1925
Hydraulic cement	1,374,399	$5,814,000	756,112	$3,117,000	+ 87.0
Pig iron	988,792	7,951,000	468,404	3,741,000	+112.5
Steel ingots, bars, etc.	192,384	4,643,000	87,413	3,074,000	+ 53.3
Iron and steel tubular products	185,614	4,726,020	122,020	2,782,000	+ 74.0
Structural shapes and building forms of iron and steel	173,131	2,863,000	96,868	1,904,000	+ 47.3
Marble, breccia and onyx in blocks or sawed, over 2-in. thick	105,664	1,320,000	108,223	1,283,000	+ 8.3
Rails for railways	82,593	1,053,000	97,121	1,313,000	— 23.0
	(Sq.Ft.)		(Sq.Ft.)		
Glass, plate, unsilvered	15,995,000	7,082,000	16,798,000	9,913,000	— 29.2
	(M.Ft. B.M.)		(M.Ft. B.M.)		
Boards, planks, deals, etc.	1,846,000	56,812,000	1,743,000	52,994,000	+ 7.2
	(M.)		(M.)		
Lath	1,969,000	10,608,000	1,675,000	10,152,000	+ 4.5
	(M.Ft. B.M.)		(M.Ft. B.M.)		
Logs and timbers except cabinet woods	212,236	3,855,000	233,146	4,228,000	— 9.5
	(M.Ft. B.M.)		(M.Ft. B.M.)		
Mahogany logs	72,363	5,692,000	53,837	4,793,000	+ 19.1
	(Number)		(Number)		
Poles, telegraph and telephone	693,188	2,989,000	625,655	2,902,000	+ 2.7
	(M.)		(M.)		
Shingles	2,513,000	9,992,000	2,568,000	9,328,000	+ 7.1
Total value of imports in this group	.....	$125,400,000	.....	$111,524,000	+ 12.4

Exports

Material	1925 Thousand Pounds	1925 Value	1924 Thousand Pounds	1924 Value	Per Cent Gain (+) or Loss (—) in Value During 1925
Boards, planks and scantlings	6,124,631	$83,026,000	5,993,546	$78,630,000	+ 5.6
Logs and timber	2,241,021	21,338,000	2,717,482	27,501,000	— 22.4
Iron and steel plates, sheets, skelp and strips	1,479,407	58,078,000	1,432,268	58,482,000	— 0.7
Iron and steel tubular products (pipes, tubes and fittings)	609,020	29,543,000	539,272	28,302,000	+ 4.4
Structural iron and steel	405,985	11,839,000	393,127	13,387,000	— 11.6
Hydraulic cement	383,368	3,003,000	330,332	2,615,000	+ 15.3
Steel rails	339,786	6,155,000	467,031	7,951,000	— 22.7
Iron and steel bars and rods	316,880	9,815,000	282,446	9,367,000	+ 4.8
Plain, galvanized and barbed iron and steel wire	230,730	7,921,000	277,939	9,887,000	— 19.9
Petroleum asphalt	178,028	1,762,000	.....	.....	.....
Natural asphalt and bitumen manufactures	92,648	1,606,000	72,590	1,214,000	+ 33.3
Railway car parts, including wheels and axles	88,911	5,781,000	106,107	7,039,000	— 18.5
Turpentine spirits	83,212	11,346,000	82,873	10,105,000	+ 12.3
Railway track material, except rails	79,222	3,250,000	80,892	3,486,000	— 5.8
Nails	42,728	2,610,000	66,193	3,539,000	— 25.7
Iron and steel bolts, nuts, rivets and washers, except railroad	37,996	2,819,000	39,189	2,931,000	— 3.4
Paints, stains and enamels	34,069	7,904,000	30,416	5,998,000	+ 33.8
	(Number)		(Number)		
Freight cars (R.R.)	6,171	7,153,000	4,973	5,474,000	+ 31.4
Passenger cars (R.R.)	240	1,214,000	221	2,032,000	— 40.0
Locomotives (R.R.)	363	7,022,000	320	5,649,000	+ 24.3
Doors (wood)	1,371,000	2,700,000	579,545	1,325,000	+107.0
Railway ties	3,105,000	2,975,000	2,471,000	2,551,000	+ 16.0
Construction and conveying machinery	.....	12,839,000	.....	10,658,000	+ 20.5
Total value of exports in this group	.....	$301,699,000	.....	$298,123,000	+ 1.1

Weekly Construction Market

THE building materials' price trend is unmistakably downward but at the same time the present level is only a fraction of one per cent under that of a year ago, taking the nation as a whole. Cement prices are stable the country over and mill quotations on steel give way reluctantly, the present weakness being mainly in sheets and plates. Most of the other materials are below last year's levels except lumber. Recovering from its recent dullness, the yellow pine market shows signs of firmness in six out of seven districts reporting, Florida being the one in which demand is slowest. The state-wide embargo on freight shipments into Florida, in effect since Oct. 29, 1925, was lifted May 15, 1926. This is probably due more to extensive railroad improvements than to decline in business, since carload traffic to Florida for the first three months of this year increased 58.5 per cent over the same period in 1925 and 102.9 per cent compared with the corresponding quarter of 1924. Cement has adapted itself to the present situation in the following manner: demand, as reflected in shipments for the period Jan. 1 to May 1, 1926, was 6 per cent under that of the same months last year; mill reserves as of April 30, 1926, were 10 per cent greater than on the same date in 1925, accordingly a decrease of 10 per cent in production was affected in order to offset the accumulated stocks and consequent danger of price decline. Revenue freight loadings, Jan. 1 to May 1, 1926, were about 2 per cent greater than for the corresponding period last year and were also heavier than during the same months in any preceding year. This indicates an actual gain in volume of general business, especially since the average load per car is a fraction of a ton heavier than a year ago. There were 16,777,076 cars loaded in the first eighteen weeks of 1926, according to the American Railway Association, against 16,493,312 cars during the same period last year. About 26 per cent of this volume was represented by construction materials and 2 per cent by automobiles and motor trucks. The drop of 8 per cent in April bank debits for the entire country, compared with the month preceding, is offset by a gain of 16 per cent over April, 1925.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.40	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$4.00
Structural rivets, 100 lb	4.50	3.50	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb	3.24	3.30	3.38	3.00	3.25	3.77½	3.20	3.25	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	48%	+35.5%	53.6%	55%	54.25%	36%	35.6@49.2%	45%	59.49
Cast-iron pipe, 6 in. and over, ton	51.60@53.60	−45.25	54.00	49.20@50.20	53.00	64.00	52.00	55.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.42
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.85	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	1.70
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	—59.00	34.00	56.00	41.00	38.75@39.25	34.75	27.00	25.00	55.00
Lime, finishing, hydrated, ton	18.20	23.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.25@2.75	1.50	1.85	2.25	1.60@1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40	10.50	11.10	12.00	14.25	12.00	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0895	10	075	076	075	....	.09	.12
Hollow partition tile 4x12x12, per block	.1112	.0895	.10	075	.076	075	.108	.09	.10
Linseed oil, raw, 5 bbl. lots, gal	—.84	—.91½	1.13	87	.95¼	—1.04	.97	1.12	1.10
Common Labor									
Common labor, union, hour	.62½@.75	30	.....	87½	.....	.50@.55	.55	62½	.....
Common labor, non-union, hour	....	25	.30@.50	82½	45@.55	.35@.50	.50	50	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 62½c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of May 6, the next on June 3.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.06). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.